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LARYNGEAL DIPHTHERIA

A Study of Seventy Cases.

Being a Thesis for the Degree of M.D.,
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by

RICHARD A. BLAKE,

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LARYNGEAL DIPHThERIA.

Introduction.

The disease now known to us as Diphtheria is of very distant origin, for it was familiar to the ancients, and was described by them. In reviewing Diphtheria Bretonneau⁽¹⁾ quotes from works by Aretaeus and Hippocrates to show that the malady was known to them. Aesculapiades about 90 B.C. had also met with the disease and he recommended laryngotomy in suffocative cases.

In the sixth century Aetius mentions a disease in which there was the formation of a false membrane and points to the dangers involved in forcibly removing this membrane. During the sixteenth and seventeenth centuries the subject was greatly worked at in Europe. Later on after the death of Louis, nephew of Napoleon, a great deal of study was given to the causation and arrest of this fatal malady, and Napoleon offered a prize on the subject, for which 83 memoirs were sent in. From these Jurine of Geneva and Albers of Bremen were regarded as premier. Referring to these essays Lennox Browne⁽²⁾ says that "The methods of treatment and the opinions enunciated by these authors forcibly demonstrate the

great lack of information which obtained at the time." Since this time Bretonneau was the observer to whom we owed most, his five memoirs being full of the most interesting details. It is to him that we owe the name of the disease for it was he who first called it Diphtherite, so called from the pseudo-membrane or pellicle which characterises the condition, the word Diphtherite being derived from the Greek word $\Delta\iota\phi\theta\epsilon\rho\alpha$.

In Britain, however, as the inflammatory origin of the disease was always doubted the termination ite (itis) was avoided and ia was the suffix used instead - the word Diphtherite being changed to Diphtheria. Bretonneau was followed in his researches by Guersant, Trousseau, Bouchut and others. Still later we find such men as Virchow, Vongraefe, Jenner, Morrell MacKenzie and many other famous clinicians devoting much valuable time to this malady. Although the disease has been known for such ages, it was not until the year 1883 that the true cause of Diphtheria was discovered by Klebs, and to Löffler does the credit go of first demonstrating the culture-characteristics, hence the organism that is the cause of the disease is now called the Klebs-Löffler Bacillus. A year or so later Roux and Yersin demonstrated the fact that the disease could be produced in all its characteristics by inoculating the toxins of the

Klebs-Löffler Bacillus, the organisms themselves having been previously either removed by filtration or destroyed by heat.

The next, and most important step in the history of Diphtheria was the publication by Behring and Kitasato in 1890 of their article on the tetanus anti-toxin, in which they stated that they were able to immunise healthy animals against the attacks of the tetanus bacillus. Then in 1891 Behring and Wernicke at the 7th International Congress of Hygiene and Demography in London, demonstrated conclusive proofs that the blood serum of animals which had acquired an artificial immunity against diphtheria by repeated injections of the toxins of diphtheria bacilli, if administered to susceptible animals would protect these latter from an attack of diphtheria. The anti-toxic treatment of Diphtheria was thereafter investigated and it was later in 1891 that it was first adopted as a method of treatment, in Berlin by von Bergman, and thereafter by several other German clinicians. The results were very unsatisfactory, chiefly because of the very low potency of the anti-toxin used at the time. In 1894 Ehrlich began to use serum manufactured from goats, instead of using the smaller animals, and in this way produced a serum which was very much more potent than that used formerly. He had remarkable

success and it is from this time that the successful treatment of Diphtheria by Anti-toxin dates. Later in the same year Katz demonstrated a series of cases treated with serum obtained from horses. This serum could be so concentrated as to require a much smaller quantity relatively to the potency and since then the horse has been universally adopted as the means of procuring Diphtheria anti-toxic serum.

Early Epidemics in Britain:

Until the middle of the nineteenth century, the disease was only sporadic in Britain, but in the year 1857 an epidemic broke out first in the South Eastern coast Counties, and later on the Eastern Counties were involved - the disease spreading from there all over the country. It was at this time that the "Boulogne Sore Throat" was so rife along the North Western shores of France. Since this time Diphtheria has been more or less epidemic in Britain, and it was a year or two later that croup became associated with it.

The Scope and Object of the Present Essay.

Working in a fever Hospital during eight months has given me much opportunity of studying Diphtheria and since the last three months of my residency at the Edinburgh City Hospital were accompanied by a phenomenal run of laryngeal cases of diphtheria (or cases which were notified as such) I had numerous opportunities of learning much that was very useful both from a clinical as well as a bacteriological point of view.

The difficulty of making an accurate diagnosis from clinical features presented themselves to one as very considerable, especially in the form of the disease I have chosen to discuss, where often for the first 24 or 36 hours (until the Bacteriological report has been sent in) one was working on a presumed diagnosis, mainly because a thorough examination was wholly impossible. This difficulty is readily illustrated by the number of cases admitted to hospitals as "croup" or laryngeal diphtheria, whereas whooping-cough before the characteristic whoop is developed, measles in the pre-eruptive stage, capillary bronchitis and even Tonsillitis, acute laryngitis, retropharyngeal abscess, foreign body in larynx and other conditions may all of them readily be and often are diagnosed as laryngeal diphtheria.

It does not require a lengthy stay in a fever hospital for one to see what a variety of conditions is notified, and admitted under the designation of laryngeal diphtheria, and it is my object in this thesis to analyse and examine 70 such cases which came under my own observation.

It is certainly very helpful and advisable from a Public Health point of view to have all doubtful cases of laryngitis isolated, but it must be remembered that notwithstanding injections of anti-toxin these patients are exposed to a certain amount of risk.

Laryngeal Diphtheria and Croup.

Laryngeal diphtheria was not regarded as a diphtheritic process until about 1830 when Bretonneau suggested the identity, although he was subjected to much controversy, he however firmly maintained his point, and he had many adherents to this view in these early days of the history of the disease, among others were such men as Trousseau, and Guersant, who strongly supported him.

Guersant, in the "Dictionnaire de Médecine" in 1835 describes croup and laryngeal diphtheria as synonymous terms. In the same article, while arguing that croup is not a new disease, Guersant

points out that the affections classed at present under the name "croup" comprise two very different diseases, namely, one in which the internal surface of the pharynx and also of the larynx and trachea is covered with pseudomembranous exudations, and another in which all these parts are simply reddened or very slightly swollen, and in which no plastic exudation is discovered. The first condition he calls membranous or pseudomembranous pharyngo-laryngitis or true croup, and the latter condition he designates by the name of laryngitis stridulosa.

Empis in writing in the "Archives Generales de Médecine" in 1850 also strongly endorses the views of Bretonneau as to croup and laryngeal diphtheria being the same disease. Bouchut in his "Traite Pratique des maladies des Nouveaux Nes" in 1858 urges the necessity of establishing a precise distinction between the two affections. The following is his diagnosis: "Stridulous laryngitis is accompanied with a dry hoarse, sibilous and more or less sonorous cough, the difficulty of breathing is extreme, the child appears as if about to perish of suffocation, still the larynx is free, and there cannot be any expectoration of false membrane. The phenomena observed are purely nervous and soon subside. They appear suddenly, and in a very high degree of intensity. The paroxysm lasts for three or

four hours, comes on during the night, is reproduced the following two or three nights in succession, gradually becomes more feeble and finally disappears, and it is not epidemic. Croup (i.e. laryngeal diphtheria) differs markedly. The symptoms gradually increase and suffocation presents itself only at the end of several days. The fits appear by day as well as by night, and they are reproduced as long as the false membranes inclosed in the larynx are thrown off. Far from diminishing gradually the fits become, on the contrary, more alarming every moment and they terminate by carrying the patient off." It must be observed from the above that while the symptoms of laryngeal or tracheal diphtheria are often very insidious and but little marked at first eventually hurry on to a fatal termination, that those of stridulous laryngitis are very prominent at first and gradually subside. The croup of Bouchut and the laryngeal diphtheria of the present day coincide almost exactly as will be seen in a little. The word croup at first used as a clinical term, later acquired a pathological significance, and as a result, much confusion and uncertainty arose, which up to the present time have not been dissipated. To the practitioner of the present day the word "croup" as applied in a diagnostic sense is very vague, from a symptomatic

point of view, on the other hand, it is expressive, indicating a very definite symptom, one common to many conditions of the larynx. It is a term employed by the public to express any condition accompanied with stridulous inspiration. Croup and diphtheria of the larynx are now regarded as one and the same disease with a common definition. "It is a specific contagious disease due to the Klebs-Löffler Bacillus and characterised by an inflammatory exudate in the mucous membrane of the larynx and trachea and by constitutional symptoms, proximal and remote - due to the action of toxins. The disease is often followed by forms of nerve paralysis." It would, therefore, be strongly advisable to drop the word croup out of medical nomenclature altogether, as of any diagnostic value, even though it has a qualifying adjective in front of it, as it is misleading to the public and it does not convey so much to the practitioner as does the more accurate terminology "Laryngeal Diphtheria".

In 1879 the Royal Medical & Chirurgical Society appointed a "Committee on Membranous Croup and Diphtheria", which committee, after considering the matter suggested "That the term croup be henceforth used wholly as a clinical definition implying laryngeal obstruction, occurring with febrile symptoms, in children."

In spite of this books and practitioners still continued to regard it as a respiratory disease, with diphtheria as a cause. Obviously recognising this uncertainty in the nomenclature, the Infectious Diseases Notification Act of 1889 calls for the notification of "membranous croup" as well as of diphtheria. Apparently there are still two classes, viz. those who wish the word croup retained as a synonym for diphtheria of the larynx, and those who wish to use it only as descriptive of the symptoms produced by laryngeal obstruction, irrespective of the cause. This latter class is the one I would strongly advocate, if the word croup is to be retained.

Goodall^{and} Washbourn⁽³⁾ who belong to this latter group, give as their definition "Croup is obstruction of the air passages, at or about the larynx, giving rise to dyspnoea, and the obstruction may be due to more than one cause, the presence of membrane, a foreign body, etc." Membranous Laryngitis is a general term and would include all conditions producing obstruction to the larynx by causes other than diphtheria.

Scheech⁽⁴⁾ classes under this heading all those affections characterised by membranous exudation, with the presence of either vesicles or hyperaemia, with swelling in the larynx.

Do Age and Sex bear any special relationship
to Laryngeal Diphtheria?

Age certainly does, for the vast majority of cases occur in children under 5 years, while nearly 50% of cases occur between the ages of 2 and 3 years. The oldest patient admitted to the wards during eight months was 9 years old. Sex does not seem to have any special relationship, 40 of those admitted being boys and 30 were girls. See the following table:-

Under one year old	5 cases	=	7.14%
" two years "	18 "	=	25.71%
" three " "	16 "	=	22.85%
" four " "	10 "	=	14.48%
" five " "	12 "	=	17.14%
" six " "	4 "	=	5.71%
Between 5 and 10 " "	5 "	=	7.14%

Total cases 70, of which 40 were boys
and 30 girls.

The Signs and Symptoms.

The functions of the larynx comprise two chiefly, namely, voice production and respiratory. The larynx is the organ almost wholly instrumental in voice production; it also forms a continuity to the channels of respiration. Therefore the signs of laryngeal derangement associate themselves with these functions. Should the vocal function be involved the result would be Dysphonia, while if the respiratory function be disordered the result would be a stridulous and dyspnoeic condition. Then too we have accompanying these two chief disorders a peculiar characteristic cough. The cough, says Guersant⁽⁵⁾ is "hoarse, stifled and dry, and appears as if going back into the larynx". It is harsh and metallic. It generally is characteristically dry and husky - sometimes accompanied by a loud barking noise. This cough is very typical of laryngeal obstruction. In the course of the disease inability to articulate, and stridor usually precode the dyspnoea, because for the production of the latter condition it requires a further degree of the disease than for the production of the two foregoing symptoms. When the breathing is affected it tends to become dry and harsh, both these characters being more marked on inspiration, as in fact it

generally is more the inspiratory phase of respiration that causes the difficulty, then expiratory. These symptoms continue for a day or two, becoming gradually more and more aggravated, until shortness of breath makes its appearance. This latter condition is markedly progressive if left untreated, and sometimes hastily terminates the patients life. I have seen a case sent from one of the Hospitals in town by the Physician on duty to the City Hospital, succumb (from asphixia) immediately after admission to the diphtheria wards, yet when the patient was sent from the first hospital the dyspnoea had not been particularly marked. This shows how very rapidly dyspnoea may supervene, also that a moderate degree of dyspnoea may become suddenly so marked as to demand instant interference.

Case to illustrate the rapid onset of dyspnoea:-

Patient, George Clark, age about 2 years, sent from R.H.S.C. When patient left the R.H.S.C. his breathing though croupy gave no anxiety - the child certainly looked pretty ill, colour being bad. On arrival at the City Hospital, within 20 minutes of its having left the R.H.S.C. the child was moribund, pulseless, with deeply sighing respirations. The colour was slaty blue and the child was thoroughly poisoned looking. Artificial respiration was necessary on arrival, and immediately thereafter patient was

intubated; the operation, however, gave no relief and immediately child was extubated, respiration again ceased, artificial respiration was again resorted to, but without response. The child was then placed on the table, a skin incision quickly made and a knife plunged into trachea, a fair opening was hastily made, tracheotomy tube placed in situ, haemorrhage very copious, respiration however had ceased in spite of artificial respiration being persevered in for a considerable time; patient had died within a few minutes of arrival. Swab, no rods found, only diplo: and staphylo-cocci. Culture, however, is positive.

From this we see that Laryngeal Diphtheria is a very progressive condition; having once appeared the symptoms almost invariably go from bad to worse, unless checked by anti-diphtheritic serum, steam and other appropriate means.

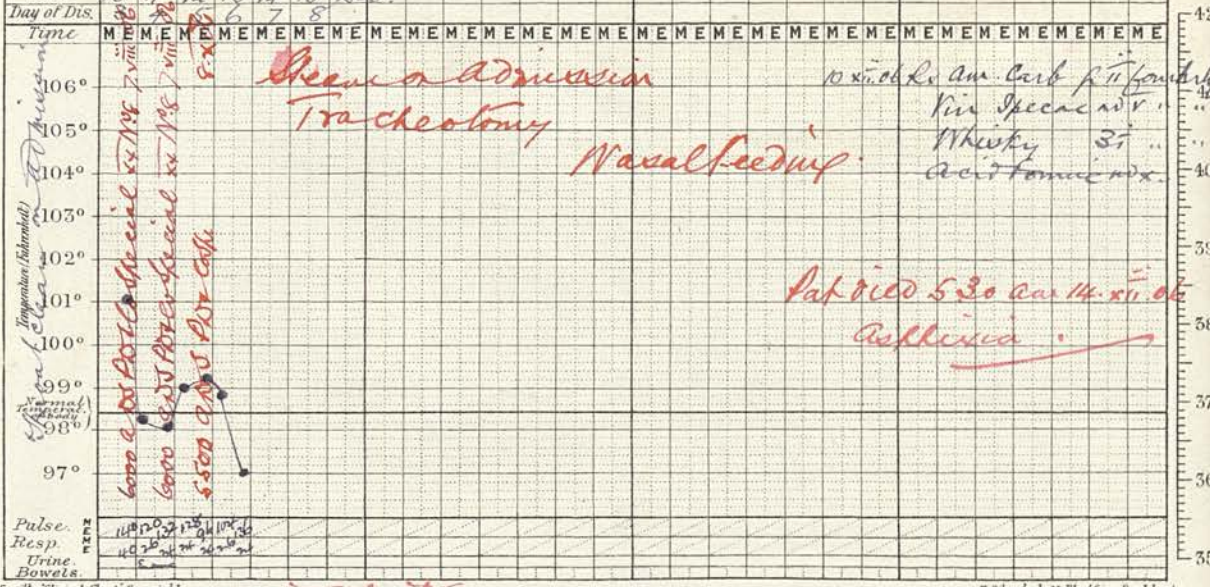
In adults the whole course of events is much less rapid, and less progressive than in children. This is probably due to the greater strength of the adult inspiratory action, and also to the smallness of the lumen of the larynx of the child.

As the condition progresses, if left untreated the patient becomes more or less livid, first round about the lips - spreading from here over the face and neck - the vessels of the neck stand out markedly,

the whole thorax moves excessively on inspiration, the epigastrium and intercostal spaces being drawn in, also the supra-clavicular spaces. The alae-nasi are either very active or remain widely dilated, the eyes are staring, the patient very restless, tossing from side to side, great beads of perspiration stand out on the child's forehead and altogether the picture portrayed by the patient is a very anxious and distressing one. The more marked the dyspnoea is the more restless is the little patient, the child also bearing a very anxious appealing expression. Should the process be left unheeded the lividity eventually gives place to pallor, (corresponding to the asphixia pallida state of asphixiation sometimes seen in the newly born infant. The livid stage on the other hand resembles the asphixia livida neonatorum; in the former condition, viz. the pallida stage, the asphixia is due chiefly to a cardiac asthenia, brought on by the respiratory embarrassment. In asphixia pallida neonatorum the condition corresponds to a respiratory embarrassment since the condition is generally brought about by a prolonged pressure either on the foetus in utero, or on the cord (or any factor) producing a non aeration of the blood, hence respiratory embarrassment and its natural sequela, cardiac asthenia. In the livida stage the condition has not progressed so far,

hence you have the non-aeration of the blood without the cardiac asthenia.) The patient becomes less restless, since he is more exhausted, the expression is one of profound anxiety and fear, the child pulls at the neck, pulls at the bed clothes and has a feeling of impending death. Fortunately it is comparatively seldom that patients are brought into hospital only when they have reached this most grave condition, for they are generally under treatment before they are so bad. When in this state, if they are not immediately assisted by operation the child would die from cardiac asthenia, brought on either by laryngeal or pulmonary dyspnoea (Cardiac failure due to a toxic condition of the blood would not come on until at any rate a day or two after this, so that death from toxaemia can at this stage be excluded); the pulmonary dyspnoea is a further stage of the laryngeal condition, it being brought about by extension of the inflammatory process downwards into the smallest bronchi and even into the smallest ramifications of the bronchi. This inflammatory extension is either in the form of pseudo-membrane or more generally of a muco-purulent substance, this condition often ushering in a fatal bronchopneumonia, unless as before stated the patient die from cardiac asthenia. When bronchopneumonia sets in to a fatal termination the con-

Name Eda Mercer Age 5 yr. Disease Diphtheria Nasal Gangrene ⁺ Result Death



W. Saville "Chemical Chart" Copyright 1907.

175000 Anti-toxin units.

W. Silverlock, 92, Blackfriars Road, London.

dition is a most distressing one, the patient often retains consciousness almost to the last and suffers death by slow suffocation. The case Ella Mercer will illustrate this condition very well.

Ella Mercer: aet 5 years;

Admitted 10th December. Died 13th December.

History of present illness. Three days ago patient complained of headache and a feeling of listlessness, she also vomited a little. Her throat gave her a little trouble the same evening. Since then her condition became gradually worse - the croupiness became evident the day before yesterday. Previous infectious diseases - measles and scarlet fever.

Stated on admission: Patient was inspiring very deeply and with much labour, the soft parts of the thorax receding very markedly with each inspiration, so much so that the patient's whole body was practically heaving with inspiration. The patient was well in the "pallida stage" of asphyxiation. The tongue was thinly furred, the papillae were not unduly prominent. The fauces were a little congested, the tonsils were slightly enlarged and covered with a thin greyness, no definite membrane was seen. The pulse was running, was intermitting very much, and had a small expansion. The patient looked thoroughly poisoned, the expression was anxious. The patient was very restless, tossing herself about in her bed.

The patient was tracheotomized half an hour after admission, she stood the operation well, the relief was immediate and complete. In spite of a good deal of coughing when the trachea was opened and a feather freely used, no membrane was found. The patient had 6000 units antitoxin administered - was put to bed, with hot bottles to her feet, steam moderately "on", hot brandy $\frac{3}{ij}$ and acid formic $\frac{ad\ xlv}{ij}$ (25% solution) per rectum. After this she fell asleep and slept well during several hours. On waking Ammon: carb: $\frac{fij}{ij}$ were administered (to be repeated four hourly).

Progress notes: 11th December 1906. Patient had a good night. She coughs very little - the trachea is very dry - no secretion whatever coming away. She is breathing nicely and is of a good colour. The pulse is steady and of moderate expansion, the temperature has fallen to normal (from 101.2° on admission). Another 6000 units of antitoxin were administered at 2 p.m. Patient has a heavy nasal discharge to-day. The swab shows mixed rods, diplo: staphylo: and few strepto-cocci. The culture from both nose and throat is positive.

12th December, 1906. Patient has had a poor night, has had severe attacks of threatened vomiting during the night, the pulse however keeps fair. She had a nasal feed at 1-40 p.m. and took it well -

also another 6000 units antitoxin were administered. Towards evening the trachea tube got blocked, was removed, cleaned and replaced, this gave only slight relief. The trachea is unaccountably dry - absolutely no secretion comes through tube - the diphtheritic process seems to be spreading, rapidly, downwards towards lungs. It is most difficult to initiate a cough, one is able to pass a feather right down the trachea, through tube, without exciting a cough. The respiration is dry whistling and wheezing in character (I have noticed that this respiratory condition is always to be regarded as of the most grave significance).

13th: Patient had very restless night - breathing very badly. There is a good deal of recession of soft parts to-day in spite of the tracheotomy tube being in situ and clean. No relief is given either by removing the tube or by passing a feather, moistened with hot bicarbonate of soda, nor yet with warm glycerine, down. Now and then very thick tenacious mucous in small fragments is coughed up the tube - almost like small pellets. The tube was blocked by such at 4 p.m. the tube was removed, no secretion, either with warm bicarbonate or warm glycerine no relief whatever. The indrawing is very marked this evening, the breathing is dry and harsh, inspirations whistling in character, patient is very

20500 Units Antitoxin

restless and distressed. This condition maintained the patient gradually becoming worse - the dyspnoeic state increasing rapidly, until by 3 a.m. (14th) the patient was in a most distressing condition. The whole process was one of slow suffocation due no doubt to a diphtheritic broncho-pneumonic condition. This condition maintained until eventually the patient was suffocated - the final being a most distressing condition.

The total dose of antitoxin administered was 17500 units.

The post mortem showed diphtheritic membrane extending down into the small bronchial tubes - more marked on the right side - also small scattered areas of lung consolidation through the lung tissue.

This case illustrates that most fatal complication diphtheritic broncho-pneumonia - and a very distressing death, namely, by slow suffocation.

Case illustrating Broncho-pneumonia complicating laryngeal diphtheria.

Ella Lees: aet 17/12 years Admitted 28th,
Died 30th.

History of present illness. The child became croupy on 26th; this condition progressed and patient was admitted 28th. No previous infectious diseases. On admission patient rather dusky colour, is very

restless and with an anxious expression.

The tongue clean, moist.

The fauces are reddened and tonsils enlarged but as far as can be seen there is no membrane present.

The alae nasi are moving freely during respiration but the patient breathes through the mouth mainly. There is fairly marked recession of the soft parts of the thorax. The lips are somewhat cyanosed. The cough is distinctly croupy, voice husky. The pulse is of moderate tension and volume. The patient has marked inspiratory difficulty, is very restless and has an anxious expression. On arrival the child was put on to full pressure steam and received Vin. Ipecac. $\frac{3}{16}$. Twenty minutes after she vomited freely but without giving much relief. As no improvement followed from the steam and the anti-spasmodics (Rx Tinct. Belladonna $\frac{1}{16}$) the patient was tracheotomized at 9-30 p.m. She took the anaesthetic well, the operation gave immediate and complete relief and the patient after coughing a good deal of thick mucous and small shreds of membrane through the tube fell asleep and slept well for the best part of the night. Swab shows some fair rods, staphylo- and diplo-cocci. The culture is positive.

29th August 1906. The patient had a fair night; breathing^{is} rather rapid this morning but colour is good. No moist sounds or rhonchi over lungs. The pulse is rapid but of fairly good quality. Fragments of membrane are being constantly coughed up through the tube. No recession of soft parts of thorax.

9 p.m. Patient in statu quo. 30th August 1906, patient had a rather restless night, she became orthopnoeic and cyanosed at times, the recession of the soft parts this morning is fairly marked. The patient, however, is very much distressed and restless, at present 1 p.m. she lies tossing about and throws herself about, also suffers of great air hunger. This condition gradually progressed, the dyspnoea becoming more marked, the breathing becoming more laboured until at 2-20 p.m. patient died of asphyxia brought about by a spread of the diphtheritic process into the small bronchi, i.e. diphtheritic bronchopneumonia. Total dose of antitoxin 20500 units.

Pulmonary dyspnoea may also be due to an inability on the part of the patient to cough, with the result that the secretions are retained and the patient may thus succumb to pulmonary obstruction. It sometimes happens that pulmonary dyspnoea manifests itself in a severe form suddenly; the patient may be quite comfortable, perhaps sleeping, will wake up

suddenly with urgent dyspnoea and the case may terminate fatally in a very short space of time, unless help is immediately forthcoming. Laryngeal dyspnoea too may be equally rapid in its onset and prove fatal, unless operation is speedily resorted to; the suddenness of the onset is probably due to the laxness of the mucosa in the upper part of the larynx, this condition favouring a rapid infiltration and a spread of the diphtheritic process in this direction.

The following case will illustrate very well the suddenness of the onset of dyspnoea, due no doubt to this laryngeal condition (the case also incidently illustrates the difficulties sometimes met with in getting rid of the intubation tube.

James Quodberg, aet 3 years:

Admitted 14th May 1906. Discharged 2nd July 1906. History of present illness. Child took ill on the 13th inst. with sick headache and some vomiting. 14th, sore throat with croupiness, previous infectious diseases - measles and whooping cough.

State on admission: (4-45 p.m.) The child is urgently croupy and much poisoned looking. There is a considerable degree of indrawing of the intercostals and epigastrium, also at the root of the

neck, the neck vessels are much turgid. The alae-nasi are very active, the breathing is harsh in character - especially marked on inspiration, expiration is much less laboured. Patient is of a dirty clayey colour and is very restless, tossing his limbs about, the expression is anxious.

On examining the fauces we find a thick white patch of dense heavy membrane on the posterior pharyngeal wall, spreading forward on to each tonsil, it being much more extensive on the left side than on the right. The uvula and soft palate are clean but congested. The tongue is coated with a thin dirty fur.

The voice is markedly croupy, inaudible. Cough very stifled and croupy. Glands - none are palpable.

Respirations are deeply laboured and moderately fast, most of the extraordinary muscles of respiration are being actively used. The pulse is fair, is regular both in rhythm and amplitude, but is readily compressible.

Half an hour after admission (5-15 p.m.) the breathing became extremely laboured - the patient becoming much cyanosed. The pulse had fallen off a great deal, being now intermittent. It was found necessary to intubate the patient at this time. There was no relief whatever, the respirations becoming more embarrassed than ever, patient was therefore

extubated within ten minutes. The child now vomited freely, a small piece of membrane was also discharged and the patient was much relieved; this continued for half an hour when breathing again became difficult, the patient also became cyanosed once more and was reintubated at 6 p.m. The relief now was immediate and almost complete. The patient settled down quietly almost at once, except for occasional coughing bouts - no more membrane has, however, been expelled. The swab shows staphylo- and diplo-, also a few strepto-cocci, also good rods, long and short. The culture is positive.

The patient received 8500 units of antitoxin on arrival.

Progress notes: 16th: Patient had a fairly good night. The pulse and temperature are both up this morning, the former from 120 to 152, the latter from 100° to 101.6°. The tongue is clean and moist.

18th: The temperature and pulse are normal this morning. The intubation tube was removed at 11-45 a.m., the patient remained fairly comfortable for 50 minutes, when respiratory embarrassment set in quite suddenly, the patient also became very restless and the pulse became intermittent. The patient was consequently reintubated at 12-45 p.m., the relief was complete and immediate.

19th: The tube was removed for nearly two hours from 11-45 this morning; patient very comfortable until just before he was reintubated when respiratory embarrassment suddenly manifested itself.

20th: The tube was out for two hours to-day, colour and pulse suddenly becoming bad at the end the patient was reintubated.

21st: The tube was out for 7 hours when reintubation was again hastily called for because of respiratory embarrassment coming on suddenly.

22nd: Tube out for 13 hours, the breathing at the end being affected long before the pulse.

23rd: Tube out for 8 hours.

24th: Tube out for 8 hours, both days patient had to be hurriedly reintubated because ^{of} respiratory embarrassment manifesting itself suddenly at the end.

25th: Tube was out for only twenty minutes to-day, the child was absolutely collapsed on being reintubated. The patient had to be freely stimulated. It was noticed here again that the respirations go off or cease altogether before the pulse is much affected.

27th: The tube was removed at 10-30 p.m. and left out for eight hours. At 6-30 a.m. patient suddenly collapsed, was freely stimulated, reintubated and artificial respiration was called for in order to restore respiration.

28th: The tube was removed at 12 p.m. but child suddenly began to fail two hours later and difficulty was found in replacing the tube. Patient coughed up a fair quantity (about $3\frac{1}{2}$) of blood immediately after.

29th: and 30th: Patient wore tube both days and is doing nicely, is rather more restless to-night; the temperature is up from normal to 101.4° .

1st June: Tube was removed at 11a.m., was out only five minutes and had to be hurriedly replaced.

4th: The temperature is swinging a good deal, patient is becoming more restless.

6th: The tube has been in situ since the first, was removed this morning at 11. The breathing in this case for the first time got worse gradually during the last 20 minutes. Intubation was performed with slight difficulty owing to the patient vomiting a good deal during the operation. The temperature still swings a good deal.

7th: The tube was out for two hours.

8th: The tube was out for eight hours.

9th: An elastic swelling was made out over the thyroid cartilage, tense, and at first difficult to make fluctuate, an incision was made in the mid-line when about $\frac{3}{4}$ oz of foetid pus was evacuated. Tube was worn all day to-day. The temperature was 102.40 this morning, came down to 100° in the evening.

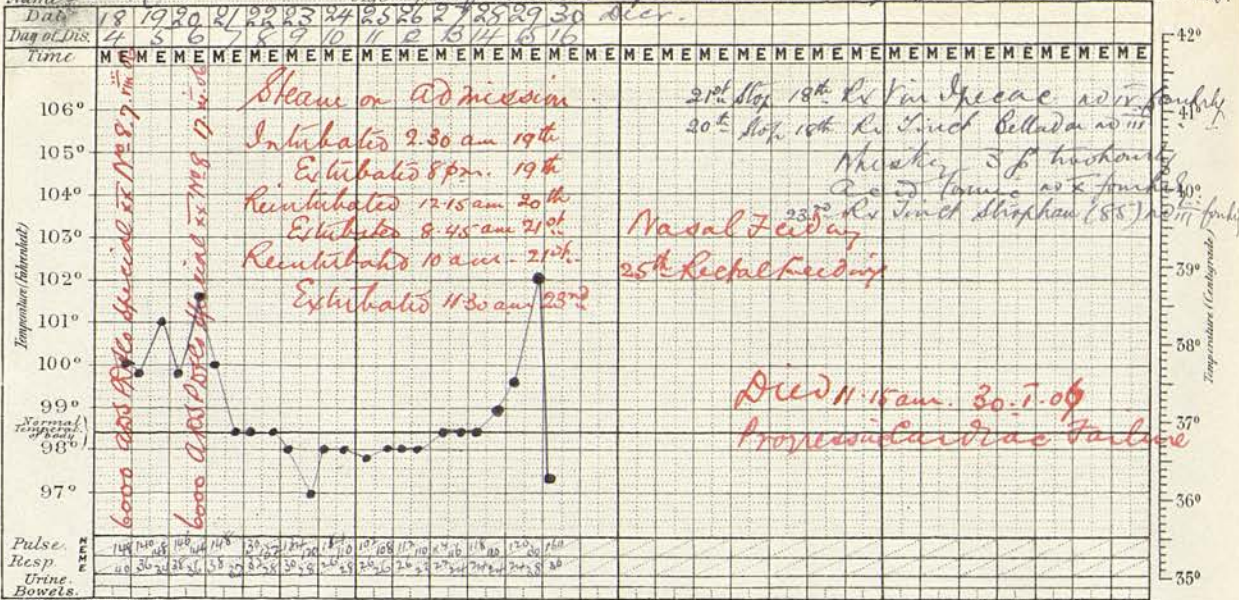
10th: Tube was removed at 11-40 this morning, has remained out all day, patient very comfortable, has slept well.

12th: The tube remains out, the child breathes quietly and normally now. The wound was dressed, looks healthy. The patient made satisfactory progress thereafter and was discharged from Hospital on the 2nd July. The total dose of antitoxin given was 20000 units.

This case has many interesting points, first what one commonly sees in these laryngeal cases of diphtheria, viz. the suddenness of the respiratory embarrassment as compared with the falling off of the pulse. It also illustrated the condition known as "retained tube" and how by dint of perseverance this difficulty was eventually overcome.

More rarely debility intervenes, no marked dyspnoea being present, the respirations instead of becoming laboured and deep are shallow and rapid - the pulse becomes rapid and thready, the patient becomes more and more livid, until shortly before death pallor sets in, drowsiness comes on and in time gives place to coma, and from this a comparatively easy death ensues. Rather more rarely death in laryngeal diphtheria is due to slow progressive cardiac failure.

Name: *Isa Hastie* Age: *1 1/2 yr.* Disease: *Diphtheria Laryngeal* Result: *- +* Death: *Death*



H. Saville "Clinical Chart" Copyright.

H. Silverlock, 92, Blackfriars Road, London.

12000 units ADS.

The following case will illustrate slow progressive cardiac failure in laryngeal diphtheria.

Isa Hastie, set 1½ years.

Admitted on the 18th December. Died 29th December. History of present illness. Patient took ill on the 15th inst. with sore throat and vomiting. Croupiness made its appearance on the 17th. Previous infectious diseases - measles.

State on admission: 10 p.m. (18th) The patient is somewhat cyanosed, is very restless and markedly croupy. There is some degree of indrawing, especially of the intercostal spaces.

The tongue has thin dirty fur, papillae are not unduly prominent.

The fauces: a distinct greyness pervades the fauces but no definite membrane can be made out.

The pulse is accelerated but is regular in rhythm, though slightly irregular in amplitude.

The respirations are fast and laboured.

On arrival the patient was put on to full pressure steam, hot fomentations were ordered round the throat and 6000 units antitoxin were administered. At 2-30 a.m. (19th) however, no improvement was manifested, on the contrary the patient was worse if anything, and it was deemed advisable to intubate the patient (O'Dwyer No.2 tube). Relief was immediate and complete, a good deal of coughing and spluttering

resulted; no membrane, however, was discharged. The swab shows mixed rods and diplo-cocci. The culture is negative.

19th: Patient had a quiet day until evening when the breathing became laboured and at 7.45 p.m. patient was extubated; the tube was found blocked with mucous; patient was greatly relieved until nearly midnight when breathing became embarrassed once more and the patient was reintubated at 12-15 a.m. (20th). The relief was complete.

A culture from the mucous in the tube gave a positive result.

21st: Patient was extubated this morning at 8-45 but breathing again became laboured almost immediately after, and the patient was reintubated at 10 a.m.

23rd: The tube was taken out finally this morning at 11-30. The patient is very quiet and listless, the pulse is becoming irregular both in rhythm and amplitude and is readily compressible. The temperature too is low.

24th: The patient had a poor night - since extubation the patient has been difficult to rouse. During last night the child vomited twice, the pulse and colour went off a great deal in consequence. The patient was freely stimulated, iced brandy

by the mouth and a hypo: of Strophanthin gr.1/150, there was very little response however.

25th: The pulse has been exceedingly feeble since last night. The patient has had in addition to the usual stimulants Rx Tinct. Straphanthus ('85 B.P.) $\approx \frac{1}{11}$ four hourly. The foot of the bed is now raised.

26th: The patient is very low, takes everything badly, the pulse is practically absent. The child is cold and clammy, in spite of being surrounded by hot tins. The patient vomited again to-day, the pulse is imperceptible.

28th: The patient is decidedly weaker to-day and takes no nourishment by the mouth - all rectal, including nourishment.

29th: Patient has been restless all day, has slept very little; towards evening the child appeared very much exhausted, was failing all evening and died very quietly at 1-15 a.m. 30th.

Total dose of antitoxin administered, 12000 units.

Diagnosis: Progressive heart failure.

The earliest signs of this mode of termination are found in the radial pulse; it becomes irregular in rhythm and amplitude, is of small expansion, and is very readily compressible, generally its frequency rises, though occasionally one finds that

the heart beats become very appreciably slower. By auscultation one finds the systole of the heart very feeble or wholly inaudible. The patient lies listless and prostrate, dislikes any signs of attention and often refuses to take food, the face also becomes very anxious in expression and is very pale, the extremities are cold and clammy, the temperature very generally subnormal may fall as low as 95°. The respirations are frequent and sighing in character, though sometimes they are very feeble and quiet, the patient sometimes retches a good deal, or actual vomiting may take place (this latter condition, having no relation whatever to the ingestion of food or liquids into the stomach.) All these points are clearly brought out in the foregoing case. Occasionally, too, haemorrhage from the nostrils sets in, at first slight and intermittent, and then to an alarming degree, lasts for some minutes, then ceases, only to start with renewed vigour and alarm an hour or two later. I have seen two or three cases terminate thus. This mode of death, however, is more frequent in cases of bad faucial diphtheria than in laryngeal conditions.

Case to illustrate heart failure preceded by haemorrhage from nose.

Jeanie Laing, aet 5 years.

Admitted 4th June. Died 9th June.

H. Silverlock, 92, Blackfriars Road, London

History of present illness. Sore throat was noticed on 1st June, vomiting on the 2nd, shivering on the 3rd.

Previous infectious diseases - Measles.

On admission, 4th June 1906, The patient is a bad colour, dusky - not cyanosed - more poisoned looking. The respirations are slightly laboured, there is some recession of the soft parts of the thorax. The cough is markedly croupy, voice husky, glands at the root of the neck are much enlarged. The pulse is rapid and weak, is only moderately steady; the tongue heavily furred, papillae not prominent. The fauces are difficult to see as the patient struggles a good deal. The tonsils are much congested and red, are both patched.

The uvula is extensively covered by dense white membrane, which appears loose at the edges and bleeds freely on being touched.

The nostrils are both blocked with membrane, the right side discharging freely, the discharge is thin and watery in character.

There are no signs of a rash, but a general flushed appearance is present, not suspicious of anything. The patient has a tendency to return fluids by the nose if allowed to drink by herself.

The swab. Good rods especially in nose, also staphylo- and diplo-cocci. Culture both nose and throat positive.

On admission the patient was put on moderately full pressure steam. Rx Vin. Ipecac. $\overline{m\overline{xxxx}}$ in a single dose was given, which soon produced emesis and relieved the child a good deal. In addition to the usual stimulants the patient was put on Liq. Strychnini $\overline{m\overline{ij}}$ four hourly. 8000 units of antitoxin were administered, fomentations were applied round the throat and the patient settled down to a good sleep and had a quiet night.

5th: The patient had a good night but the diphtheritic process seems to be spreading in spite of liberal supplies of antitoxin. The pulse is less good to-day, is intermitting a good deal and is readily compressible. The respirations are deep and sighing in character and the patient is restless.

6th: Only moderate night. The nose bled considerably this morning. The pulse was a little improved but fell off again considerably towards evening.

7th: Patient had a restless night, the pulse is irregular and unsteady in beat. The condition of the child has not improved, the nose bled again profusely this afternoon, and stopped only after being plugged with swabs of cotton wool moistened in adrenalin chloride (1 in 2000).

9th: Much haemorrhage from nose again last night. This morning (11-40) the face is pale, nose very cold, pulse varies a good deal, at times it is not palpable at the wrist. Heart rate 168 per minute, heart sounds, however, are fairly intense.

10th: The child's condition gradually grew worse; haemorrhage from nose became profuse, vomiting ensued and patient died at 7-20 this morning.

The total dose of antitoxin administered was 40000 units, see chart opposite.

As a rule these symptoms are gradually progressive until the end; but frequently cardiac failure sets in suddenly and without any warning. The patient is as a rule conscious to the last. Should heart failure intervene it very generally does so when the diphtheritic process is at its height, generally between the fifth and the tenth day of the disease.

Table illustrating cause of death in the 14 fatal cases:-

4	Died of Progressive Heart Failure.
4	" " Diphtheritic Pneumonia.
2	" " General Toxaemia.
1	" " Sudden Asphixia.
1	" " Progressive Asphixia.
1	" " Septic Pneumonia.
1	" " Measles complicating Laryngeal Diphtheria.

Total 14 = 20% Deaths in 70 Cases.

Of these fourteen deaths six occurred within 48 hours of admission:-

<u>George C.</u>	Ill 14 days at home, tracheotomized immediately (after three attempts at intubation), death within five minutes.
<u>George L.</u>	Progressive cardiac asthenia, died in 18 hours, ill at home 14 days.
<u>Ella F.</u>	Died 20 hours after admission. Measles and Diphtheria.
<u>Arthur H.</u>	Died 30 hours after admission of diphtheritic pneumonia.
<u>James A.</u>	Died 36 hours after admission of diphtheritic pneumonia.
<u>Ella L.</u>	Tracheotomized immediately, died 40 hours after, of Asphixia.

The Cause of this Heart Failure:

According to Hecktoen and Riesman⁽⁶⁾ it is due to "Extensive alterations in the myocardium without necessarily involving the endocardium or pericardium. These alterations affect the muscular substance, interstitial tissue, blood-vessels and nervous mechanism of the heart. The heart muscle undergoes a hyaline and granular degeneration, the muscle nuclei become enormously distended and elongated or divided into numerous segments. In addition to these changes, vacuolization and segmentation of the muscle fibres are frequently seen. The interstitial tissue becomes infiltrated with round cells, either singly or in groups, these cells are found most abundantly round the blood-vessels, and Romberg believes that in cases of recovery from this acute disease this lesion may be followed by the formation of circumscribed fibrous patches, which may seriously impair the functions of the heart, and ultimately induce secondary changes in the myocardium." Hecktoen and Riesman go on to say, "Important changes are sometimes observed in the blood-vessels of the myocardium, thus there may be swelling of the intima, hyaline degeneration of the media and leucocytic infiltration of the adventitia. The most significant vascular lesion, however, consists in the presence of hyaline thrombi in the

small arteries. The effects of these occluding thrombi on the functional activity of the heart can be readily appreciated". We see similar changes to these just mentioned in death from most of the specific fevers, so that this is not peculiar to death from the toxins of diphtheria.

These are the effects of the toxins on the heart but very important changes occur in the nerves enervating the heart and this forms a very special factor in the production of heart failure. The two vagi undergo a parenchymatous and interstitial degeneration.

Primary and Secondary Laryngeal Diphtheria:

The disease may occur primarily in the larynx but we are still in doubt what factors determine the ingress of the bacilli into the laryngeal mucosa, though clinically we do see many such cases. Laryngeal diphtheria more generally is not a primary condition, but follows as a secondary infection to that of the fauces. Under the heading of Primary cases are classed all cases in which the fauces are free from membrane, but the bacteriological result is positive from the larynx.

Secondary cases comprise those in which the larynx has become infected secondarily to a faucial condition (or nasal).

Laryngitis cases include all cases in which the bacteriological examination has been negative on two consecutive examinations.

Out of 70 cases admitted to Hospital under my charge

13 cases = 18.5% were Primary.

48 " = 68.6% " Secondary.

9 " = 12.8% " Laryngitis.

Of the fatal cases:-

1 was a Primary case

11 were Secondary cases.

1 was a laryngitis case.

1 was a laryngeal obstruction case.

Diagnosis	Number of cases	Average dose of antitoxin	Number of cases operated upon.	Number of deaths	Average number of days in Hospital
Primary	12	7944.4 units	5	1	37 days.
Secondary	43	14355.5	18	4	37.8 days.
Laryngitis	8	6000	1	1	31.5 days.
Laryngeal obstruction	1	9000	1	1	5 days.

N.B. This table excludes all cases (6 in number) which died within 48 hours of admission to Hospital.

Since then laryngeal diphtheria does occur as a primary lesion, one would be quite justified in notifying a case of laryngitis as diphtheritic, and this would be much the safer course to adopt, unless one could be definitely certain that the cause of the laryngitis is other than a diphtheritic one. I would strongly recommend that all cases of laryngitis of doubtful origin be carefully watched and if there be the smallest suspicion of it being diphtheritic, it be treated as such, until you can be definitely certain that you are dealing with a condition less serious, and you can generally be sure in the course of a day or two both from a bacteriological and symptomatic point of view. This is all to be done with a view to saving time should the case actually turn out to be one of diphtheria of the larynx, and in laryngeal diphtheria above all others, every hour saved means so much to the chances of the patient. I cannot emphasise this point too strongly as laryngeal diphtheria untreated, or in which treatment is delayed is a most fatal condition. The earlier the treatment is initiated, the more hopeful is the prognosis. The following table of statistics taken from Allbutt and Rolleston will illustrate this point very clearly, from the antitoxine treatment point of view alone.

Should the serum be given on:-

1st day of the disease,	the mortality is	3.5%
2nd " " " " " "	is	8%
3rd " " " " " "	is	12.8%
4th " " " " " "	is	23.6%
5th " " " " " "	is	35%

The above is Biggs and Guerards table.

While this table refers to cases of faucial diphtheria, it must be remembered that the mortality occurring in laryngeal diphtheria is much higher. Nothnagel⁽⁷⁾ states: "That the number of cases of laryngeal diphtheria coming to operation with anti-toxin treatment has been reduced one-half. Where operative interference is deemed necessary intubation seems to give better results than tracheotomy in the proportion 42% to 30.8%".

The inconvenience caused by the administration of antitoxin (as will be seen later) is so slight in the very great majority of cases that one would be quite justified in giving the patient the benefit of the doubt and inject the serum on making your provisional diagnosis.

This latter remark refers more especially to children, in whom diphtheritic laryngitis is so much more common and more fatal than it is in adults.

The Signs and Symptoms in detail:

The first sign of involvement of the larynx, whether primary or secondary, is the occurrence of hoarseness and the development of a so-called croupy cough. This continues for a day or two, then either disappears or more generally as a result of increased obstruction, the voice may be so interfered with as to be reduced to a mere whisper. The cough becomes more and more obstructive and stridulous, the breathing noisy, and interrupted by attacks of dyspnoea, which, should relief be not forthcoming, may either end in suffocation or less frequently in the discharge of the pseudo-membrane, either en masse or piecemeal.

The cough Guersant⁽⁸⁾ says is "hoarse, stifled and dry, and appears as if going back in the larynx." At first there is a natural vocal element, which, however, gradually loses itself, the cough becoming more and more toneless and muffled. Expectoration is generally very scanty or wholly absent. During the attacks of coughing the face is often noticed to become dusky and the lips cyanosed, while the eyeballs are very prominent and staring. This, together with the restlessness of the patient, and a catching at the neck or tugging at the neckband, struck one as very characteristic. The attacks

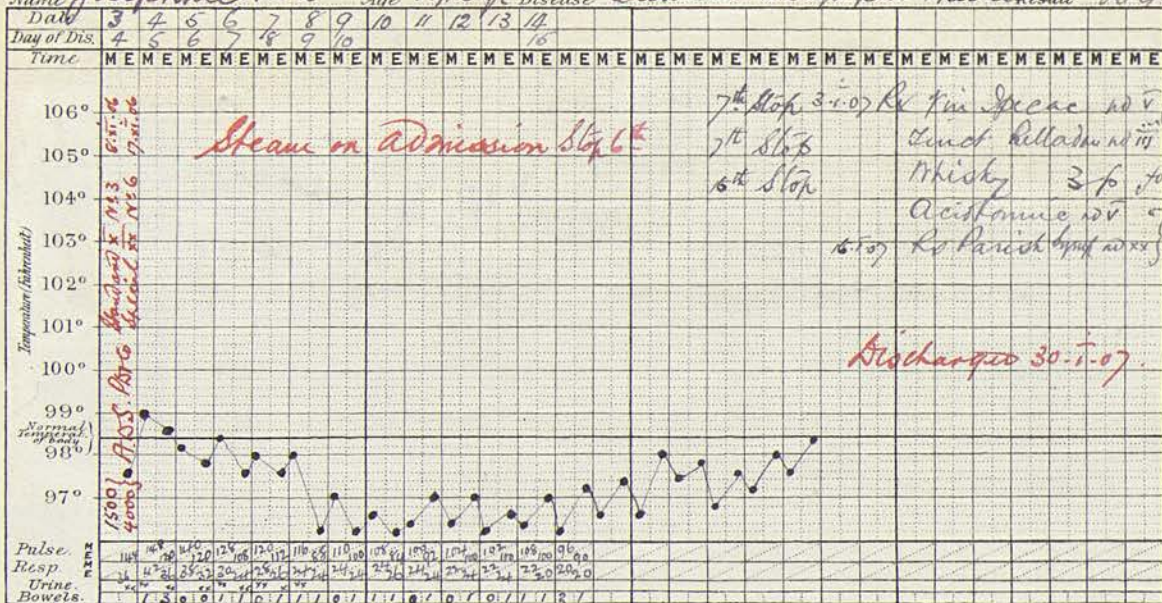
of dyspnoea, Nothnagel⁽⁹⁾ says "four theories have been advanced as to the cause, viz: (1) spasm of the glottis, (2) obstruction due to the false membrane, (3) paralysis of the dilators of the glottis (Niemeier), (4) excitation of respiratory centres by carbonic acid poisoning, and reflex action of the pneumo-gastric nerve (Cadet de Gassicourt)." Nothnagel goes on to say that it is a common experience at autopsies on children dying from asphyxia in laryngeal diphtheria to find little or no membrane about or in the larynx; my limited experience on autopsies bears this out in at least one or two cases. Then, too, the attacks of dyspnoea come on so suddenly that one cannot help but suspect their origin to be nervous; in favour of this is the fact that all the muscles of the larynx save one pair (crico-arytenoidei postici) are constrictors; again the fact that anti-spasmodics will often quieten and give the patient temporary relief is in favour of it being of nervous origin. Sometimes, too, in intubating the patient you find your intubation tube gripped by a spasmodic condition of the glottis and immediately the obstruction gives and the tube enters the larynx. All these facts go to support this hypothesis of spasm. The spasmodic condition of the glottis, then, is in all probability the cause of the exacerbations of

dyspnoea to frequently seen in these laryngeal cases of diphtheria.

Fever in laryngeal as in other forms of diphtheria, unless complicated in some way by other conditions, rarely is a prominent symptom, in fact after the initial fever lasting for 48 to 72 hours and which falls by a lysis, the temperature is as a rule subnormal; this is in marked contrast to other inflammatory conditions of the throat unless there be some complication, then, or a recrudescence, the temperature remains subnormal after the first two or three days. This is especially seen in cases of pure diphtheria, but when mixed infection obtains one as a rule sees the temperature persisting much longer. The lowness of the temperature is in all probability due to the toxic condition of the patient's blood - the diphtheria toxin having a markedly depressing action on the whole system.

The pulse as a rule is rapid at the beginning of the disease but a speedy fall is generally seen after the initial dose of anti-toxin, though many authorities maintain that antitoxin accelerates the pulse. A too rapid or extreme fall in the pulse rate is always to be regarded as a grave symptom in children: in adults, however, one is inclined to regard a fall in the pulse as of less moment than in children. A rapid running pulse, too, must be

Name Josephine Kerr Age 19/12 7/4 Disease Clinical Laryngeal + faucial + Diff. Record



regarded as of serious import, but of more gravity in my experience is the case in which the pulse becomes slow especially if this slowness is accompanied by an associated irregularity - this is of extreme gravity and often is the initial stage of a progressive cardiac failure.

One peculiarity I have noted in the pulse in a majority of cases of diphtheria is the tendency for it to be very appreciably faster in the morning than in the evening. I have not been able to assign a cause to this behaviour of the pulse, unless it is that the rest the patient has had during sleep helps in overcoming the depressant action the diphtheria toxin has on the cardiac muscle and thus accelerates the pulse.

Case, Josephine Kerr, illustrates this peculiarity on the part of the pulse very well.

Josephine Kerr, etc 1 ⁸/₁₂ years.

Admitted 3rd December. Discharged 3rd January, 1907.

History of present illness: Patient ill with shivering and vomiting on the 30th November. Was admitted on the 3rd December.

Previous infectious diseases - Nil.

State on admission: The patient is much flushed and also somewhat cyanosed. There is no rash but a well marked circumoral pallor. The

tongue is heavily furred, but the papillae are not unduly prominent. The patient is very restless.

Respirations are markedly laboured and are accompanied by a considerable amount of recession of the soft part of the thorax.

The alae nasi are actively working and often remain widely dilated.

The pulse is rapid, poor, irregular both in rhythm and amplitude and readily compressible, is of small expansion.

The fauces are clean and injected. The tonsils are slightly enlarged and granular. The right one is fairly well patched.

The voice is markedly croupy, and has little or no vocal element.

The glands at the angle of the jaw are enlarged.

The swab shows indefinite rods, diplo- and staphylo-cocci. Culture is positive.

On admission the patient was put on to full pressure steam, antispasmodics and stimulants, also 5500 units of antitoxin were administered. The case progressed very satisfactorily and was discharged home on the 3rd January 1907.

N.B. This case readily illustrates the peculiarity of the pulse - it being very appreciably faster in the morning than the evening. This fact I have

noticed in the majority of my cases of diphtheria in Hospital (see Chart opposite).

Restlessness is characteristic of laryngeal cases of diphtheria, the more pronounced the obstruction the more aggravated is the restlessness. If the condition has not progressed very far the patient tosses in his bed only now and again, but should the obstruction be well marked he throws his limbs about, pulls at the bed-clothes, catches at his throat and rolls his head from side to side. I have noticed that these little patients always work their way up the bed until they get their heads right against the bars, here they lie first to the one corner and then to the other. After intubation, and generally after tracheotomy, it is next to impossible to keep the patient covered. You cover them up and immediately they kick the bed clothes off; this goes on time and again until eventually you desist and clothe them warmly in woollens and long stockings. This keeps the child warm and he ceases to kick at the bed clothes. This kicking off of the bed clothes is characteristic of intubated (and generally tracheotomised) cases of laryngeal diphtheria; whether it is a reflex action or not I am not prepared to say, but one sees it in practically every case which has been intubated.

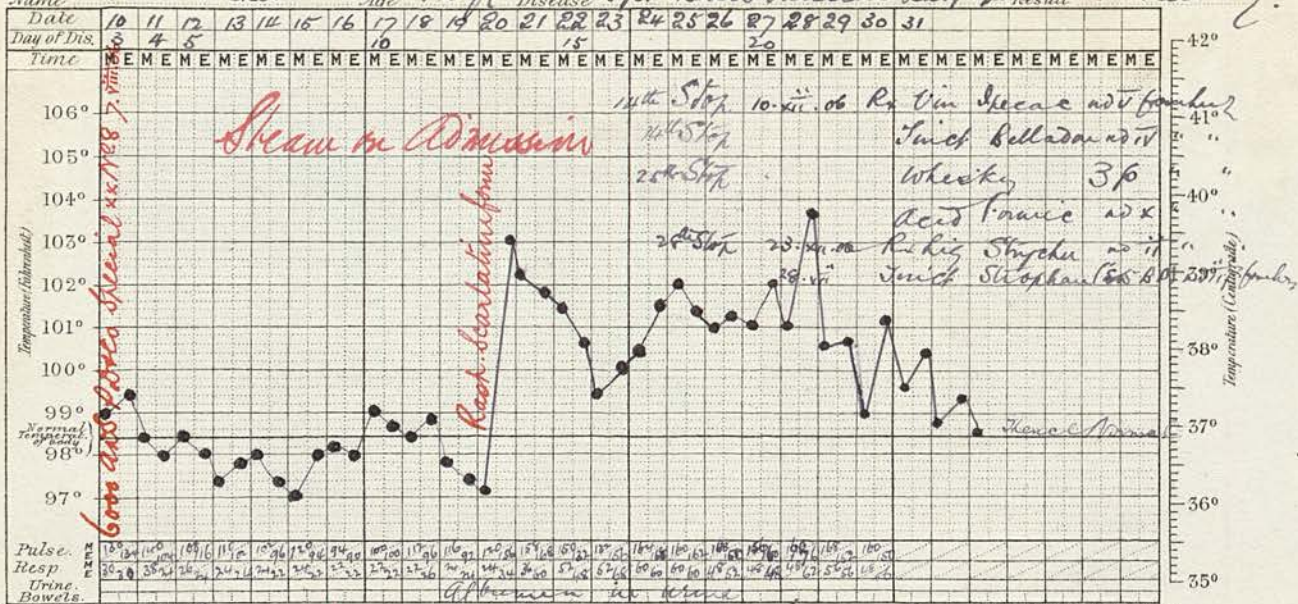
The Course of the Disease:

Laryngeal diphtheria may be divided into three stages: (1) stage of invasion, which includes the cough, the hoarseness and some swelling of the larynx (seen on laryngoscopic examination).

This stage lasts on an average from one to three days. The second stage is merely a progression of the former. (2) The stage of aphonia, of spasm and of exudation. This stage generally begins with the formation of the pseudomembrane. This condition often proceeds rapidly; the cough at this stage is short, dry and hoarse, and comes on in the form of paroxysms; during the attack the patient becomes cyanotic, the veins at the root of the neck are distended, the eyes are prominent, the expression is anxious and the brow is covered by a cold clammy sweat. Aphonia, too, hastily comes on and is generally complete. The respiration is laboured and noisy. The soft tissues of the thorax recede on inspiration, which is markedly prolonged. This condition sometimes goes on to an attack of asphyxia: the patient sits up in bed, pulls at the neck, throws his arms about, and his head well back. It sometimes happens that at this stage the patient coughs up a membranous cast of the larynx and the symptoms for the time are greatly relieved, but more generally the condition goes on to the third stage.

Chart of case illustrating intercurrent Scarlet Fever

Name William Short Age 1 1/2 yrs Disease Diphtheria faucial Laryngitis Result + Recovery.



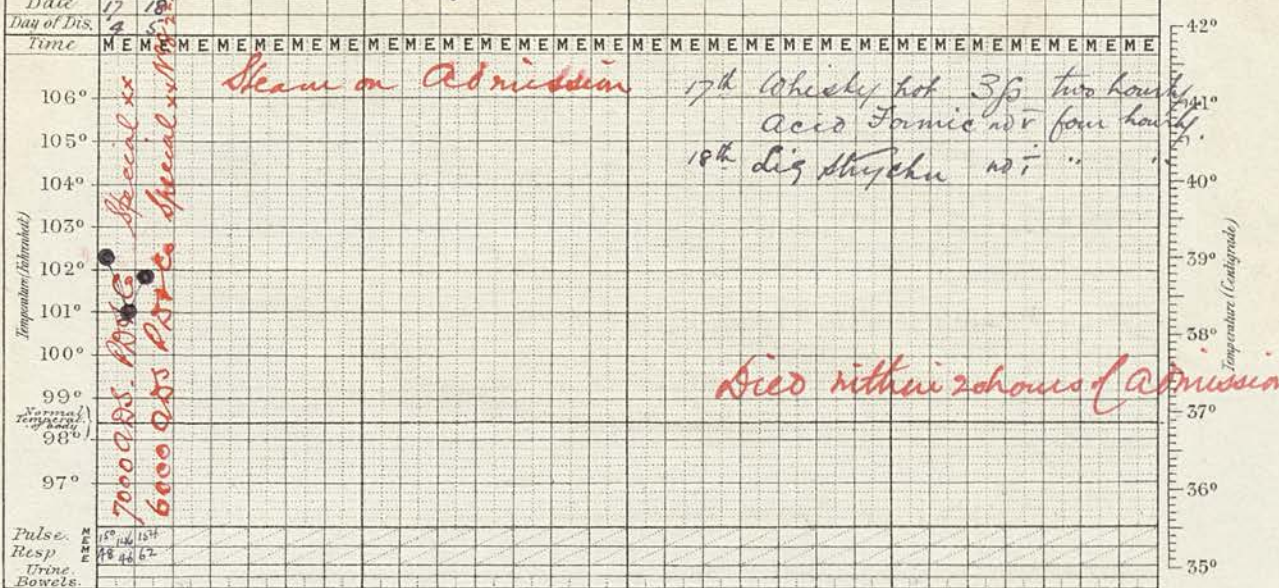
(3) The stage of suffocation. In this stage all the accessory muscles of respiration are brought into play. The recession of the soft parts is very pronounced, the air hunger becomes marked, the patient is livid, the skin cold and clammy, the patient tosses about the bed, rolls his head from side to side and bears a most anxious expression; the condition progresses, the patient becoming at last apathetic, coma eventually sets in and the patient dies. According to Monti out of all cases untreated 95 to 98% terminate fatally. Death is usually due to a toxic condition of the blood produced by an excess of carbonic acid gas in the blood, or less often by one of the complications such as broncho-pneumonia.

Complications and Sequelae:

Guersant⁽¹⁰⁾ mentions the occurrence of pseudo-membranous gastritis, he quotes a case where the post mortem examination revealed the presence of membrane in the stomach. He also met with bronchitis frequently; the same writer comments upon the frequency of pleuro-pneumonia.

True diphtheria does often complicate measles. (See chart opposite)
Scarlet fever too often is intercurrent. Whooping cough, Guersant says, in the Revue Médicale, often is favourable since the shocks of the cough by

Name *Ella Fraser* Age *1 1/2 yr* Disease *Diphtheria (Laryngeal) Membranes* ⁺ Death



promoting the discharge of the membrane, contributed to the favourable termination.

I have had cases illustrating each of the latter three complications, the case complicated with measles eventually proved fatal. (vide case Ella Fraser).

Ella Fraser, aet 11/12 year.

Admitted 17th. Died 18th, twenty hours after admission.

History of present disease: Patient has been sneezing and coughing for a week. She took a sore throat and headache on 14th: slightly croupy on 16th. No previous infectious diseases.

State on admission: Baby very ill looking, is a bad colour. Throat ragged and congested. Tonsils are not clearly seen because of mucous. The palate has a nasty patch and apparent excavation on the right side. The uvula is free, congested. Some enlargement of glands at angle of jaw. No signs of any rash on back. On thorax, however, early maculi-papular rash coming. Tongue thickly furred. Some suspicion of stomatitis on palate and traces of ill-developed Koplik spots on buccal mucosa. Pulse thin, rapid and small but regular. Nose is discharging freely. The voice slightly is croupy. Respirations are not laboured but there is a slight recession of the soft parts.

18th: The child was breathing very badly all night and did not rally at all in spite of stimulants; she died towards evening.

Total dose antitoxin, 13000 units.

The swab. Mixed rods. Staphylo- and diplococci. Culture was positive.

Pericarditis is sometimes, though fortunately, seldom seen. Broncho-pneumonia unfortunately is common and most fatal. (vide case Ella Lees, page 20)

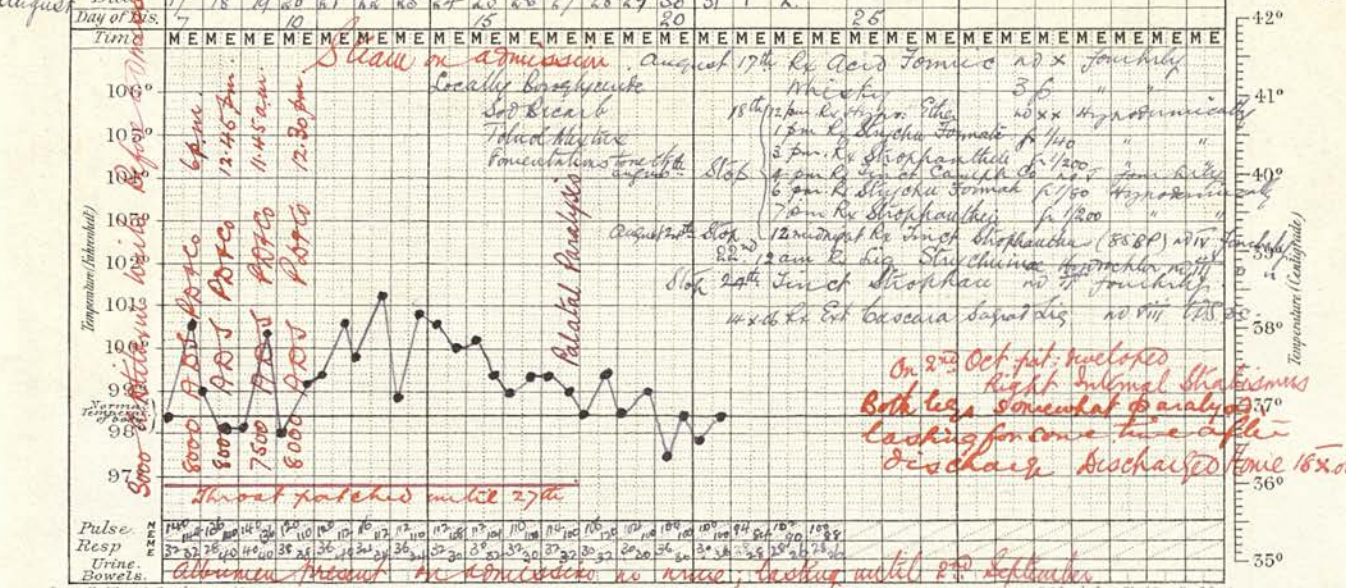
After tracheotomy one sometimes gets surgical Emphysema, pneumo-thorax, and abscess formation in the lung due to mixed infection. Marie Jackson's case (q.v.) probably illustrated this latter condition. Probably to begin with the case was not mixed but later on became such, by way of the tracheotomy tube.

One very often finds the glands at the root of the neck and the sterno-mastoid glands enlarged.

Slight albuminuria, too, is quite a frequent complication with laryngeal diphtheria, but is of little or no moment. Paralysis of various parts sometimes occur after laryngeal diphtheria, though it is stated that paralysis after laryngeal diphtheria is less frequent than after faucial and still less than after nasal cases of diphtheria. Threatened heart failure is a most anxious complication.



Name Anna Black. Age 4 1/2 Disease Diphtheria faucial Palatal Laryngeal + Recovery



It is generally ushered in by retching and vomiting - also sometimes by severe epistaxis.

The following case illustrates various paralyses also threatened cardiac failure.

Anna Black, aet 4 years:

Admitted 17th August 1906. Discharged 18th October 1906.

History of present illness: Patient is said to have taken ill a week ago (on 10th). Sore throat was noticed on the 12th. Shivering and headache on 15th. Vomiting and croupy on 16th. Previous infectious diseases - Measles and Chicken-Pox.

State on admission: The patient looks fairly poisoned, is dusky coloured, the respirations though a little fast are quiet: there is no recession of the soft parts of the thorax. The alae nasi are not perceptibly active. The expression is somewhat anxious.

The tongue is covered with a thick creamy white fur, the edges are clean, the papillae are not unduly prominent. The fauces are red and hyperaemic. Both tonsils are enlarged, the left one being completely obscured by a thick dense white membrane, which is adherent and not easily detached: it extends forward on to the soft palate. The right tonsil and uvula are patched, the membrane here being less dense in consistence. The pulse is regular

in rhythm and amplitude and is of moderate expansion and tension.

The glands at the angle of the jaw are enlarged.

The cough is very distinctly croupy. The voice is almost absent, the vocal element being all but away.

The swab. Some fair faint rods, staphylo-diplo- and strepto-cocci. The culture is positive but chiefly staphylo-cocci.

Progress Notes:

18th: This morning the membrane is raised and seems looser. Patient refuses to swallow milk or medicine, was consequently fed by means of nasal tube - became very cyanosed and livid, then ceased to breathe. Artificial respiration was immediately practised and patient soon came round. She coughed a good deal subsequently and got rid of a small piece of membrane. The pulse this morning is regular in character but of small expansion and readily compressible. The rate is 136 per minute.

1-30 p.m. Patient quieter but colour is bad.

3 p.m. Patient very restless but is swallowing better now.

19th: She slept very well from 11 p.m. and is not restless to-day. The colour is somewhat

better. Pulse 128, and slightly improved. There is no diminution in the membrane in spite of liberal supply of antitoxin. (see the chart opposite).

22nd: The patient is very restless; has had a fair night. To-day she has several times threatened to vomit. Recourse was had to rectal feeding, iced brandy only being given by the mouth. A mustard leaf was applied to the epigastrium and the foot of the bed raised as pulse had gone off very considerably, was intermitting and very feeble. The patient is very listless this evening and Liq. Strychn. Hydrochlor. $\text{M} \frac{\text{iiij}}{\text{ij}}$ was ordered four hourly.

27th: Patient has developed a palatal paralysis and is unable to swallow. Nasal feeding was ordered, unfortunately patient takes these badly. The pulse still is very poor.

6th: Patient is making but little headway, the pulse is very feeble and unsteady. The patient very listless. The urine has been loaded with albumen since admission until the 2nd inst. but now the urine is free from it. Still on nasal feeds only.

10th: Patient is improving slowly - pulse better.

15th: Patient has now had a second pillow for a few days; the pulse is much improved; the child takes an interest in her surroundings now. Her

cot has been out on the Balcony every day during the past week.

20th: Patient has been in a chair for an hour to-day.

25th: Patient trying to walk, is very weak.

2nd: Marked right internal strabismus has developed. Patient unable to control right eye.

4th: Slight paralysis in both lower extremities. Most of the reflexes are absent.

10th: Patient has much improved. Is getting fat.

18th: Discharged home well. Patient continued to improve steadily at home.

Total dose of antitoxin administered was 34500 units. See chart opposite.

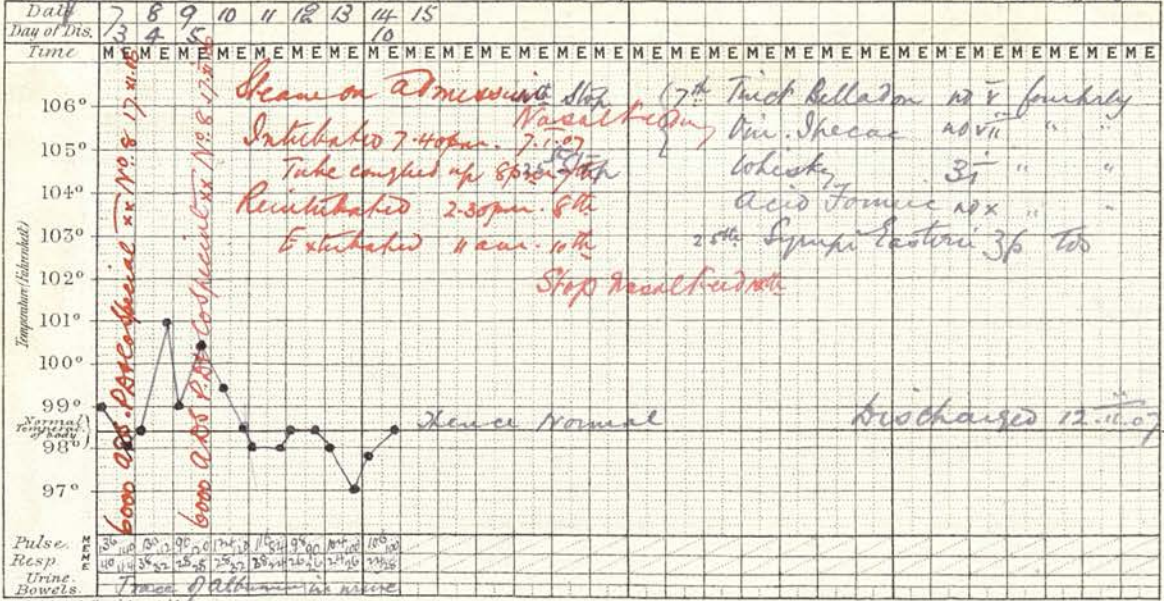
Nasal diphtheria not infrequently goes hand in hand with laryngeal diphtheria, and such cases must always be regarded with more anxiety, on account of the very free lymphatic supply the nasal mucous membrane has.

Case to illustrate nasal diphtheria as a primary condition to laryngeal diphtheria.

James Henderson: aet $4\frac{1}{2}$ years.

Admitted 7th January 1907. Discharged 12th February 1907.

Name James Henderson Age 4 1/2 Disease Diphtheria faucial nasal hemorrhagic + Recovery



History of present illness: The patient has been ill (?) since the 27th December. Sore throat complained of 5th January. Croupy on 6th. Admitted 7th. The patient had had measles ten days ago, this probably accounts for the patient being ill since the 27th December. The child probably contracted diphtheria about the 4th.

On admission patient is slightly cyanosed, the respirations are fairly laboured, are accelerated, frequency being 40 per minute. Recession of soft parts well marked, the alae nasi are active.

The fauces are injected. The tonsils slightly enlarged, are all clean. There is a fairly copious thin watery discharge from both nostrils. On examining the nostrils one sees a heavy dense white membrane on the turbinals, both nostrils are almost entirely blocked by this membrane.

The voice is markedly croupy. The glands at the angle of the jaw are distinctly enlarged. The pulse is accelerated but of good quality.

On examining the back, we see a discrete punctiform rash, fairly bright, distributed irregularly over the body, also less marked on chest. The tongue is not suspicious.

Progress notes: Later the breathing became so bad that it was deemed necessary to intubate the child 7-30 p.m. (O'Droyer No.4). Patient coughed

and immediately thereafter he sneezed out of each nostril a large dense membranous cast - almost of the consistence of chamois leather. After this patient settled down fairly well. Later coughing began afresh and the tube was expelled; the patient was now greatly relieved and fell asleep.

8th: Patient had good night - not requiring to be reintubated. Progressed thereafter very satisfactorily.

Swab. Nose and Throat. Good rods, diplo- and staphylo- (also strepto-cocci from throat). Culture positive.

Total does of antitoxin 12000 units.

The following table represents the complications or sequelae in the 70 cases analysed.

Albumen in Urine	21 Cases
Diphtheritic broncho-pneumonia ..	7 "
Threatened or actual heart failure	10 "
Paralysis (various).....	3 "
Herpes Labialis	2 "
Jaundice	2 "
Otorrhoea	3 "
Scarlet Fever	2 "
Measles	1 "
Whooping Cough	1 "
Epileptic Fits	1 "

Differential Diagnosis:

The diagnosis between the acute infections of the larynx as to whether they are primarily diphtheritic conditions or not is quite impossible except by a bacteriological examination. A laryngoscopic examination is practically impossible, as the vast majority of cases occur in children under five years of age, and in whom a laryngoscopic examination would be a matter of the greatest difficulty.

In my opinion it is merely subjecting the little patient to unnecessary strain and fear, and is much better done without.

Laryngeal diphtheria begins insiduously with signs of laryngeal irritation, cough, hoarseness, etc., but when once established, it progresses rapidly, dyspnoea and signs of stenosis rapidly following each other. It can generally be recognised from a catarrhal condition by the greater severity and the steady progressive condition of the former: then, too, the catarrh in the larynx is generally associated with catarrhal conditions in the trachea or bronchi.

Laryngismus stridulus is generally a sudden condition - occurring in the night time or early morning. The attack, however, readily passes off and is not progressive like laryngeal diphtheria.

Retropharyngeal abscesses may occasionally be confounded with diphtheria of the larynx, but here a digital examination would soon clear the diagnosis.

Other laryngeal conditions such as foreign body in the larynx, syphilitic or tubercular ulceration, the laryngitis due to the exanthemata and oedema glottidis will be diagnosed from the history of the condition.

Broncho-pneumonia may sometimes simulate laryngeal diphtheria, but its mode of onset is different, and examination by auscultation often will clear up the condition. Still it occasionally happens that cases of broncho-pneumonia are notified as laryngeal diphtheria. You sometimes get marked dyspnoea in such cases, and should it happen that a case be complicated with a laryngitis, the cough may be rendered slightly stridulous and in this way broncho-pneumonia may readily be diagnosed as laryngeal diphtheria.

Prognosis:

Must always be guarded, the gravity depending upon many circumstances. No other infectious disease is so uncertain as to its results as is diphtheria, for occasionally cases that appear most benign succumb, while on the other hand some of the

worst cases of diphtheria recover. The prognosis must always be more guarded after intubation and still more so after Tracheotomy. The gravity is also increased by the presence of any previous or subsequent lung condition such as broncho-pneumonia, acute lobar pneumonia.

The age of the patient is a very important factor, children under one year seem to withstand the disease better than their slightly older friends, the fatality being highest according to the Boston City Hospital reports at the ages of from one to three. My own experience coincides with this as 50% of my fatal cases occurred between the ages of eighteen months and two and a half years.

The favourable age in laryngeal diphtheria is between three and twelve years.

The duration of the disease prior to treatment forms one of the chief guides in giving a prognosis. The longer the patient has been ill the less is there a chance of favourable termination.

Biggs and Guerard's table would here again be interesting:

1st day of the disease mortality percentage							3.5
2nd	"	"	"	"	"	"	8
3rd	"	"	"	"	"	"	12.8
4th	"	"	"	"	"	"	23.6
5th	"	"	"	"	"	"	35

It must be remarked that this table refers to faucial cases and that the mortality in laryngeal cases is much higher.

The following table represents a short analysis of cases under my observation, with reference to days ill before admission, number of deaths, etc. Antitoxin, and days in Hospital.

How many days ill before admission?	Number of cases	Number operated upon	Total deaths	Average dose of antitoxin	Average number of days in Hospital.
1 and 2 days	8	2	$\frac{1}{8.3\%}$	5875 units	26.5
3 and 4 days	25	13	$\frac{7}{28\%}$	15560 units	28.7
5 and 6 days	15	11	$\frac{4}{26.6\%}$	18266.6 units	33.6
7 and 8 days	7	3	0	13142.8 units	40 days
10 days	1	1	$\frac{1}{100\%}$	10000 units	56 days
14 days	1	1	$\frac{1}{100\%}$	10500 units	18 hours
Indefinite and doubtful history.	13	2	0	12500 units	28 days.

One must also always remember the liability to cardiac failure. The method of treatment is a very important factor in the prognosis, for as above stated the number of cases coming under operation after antitoxin treatment has been reduced one half. The mortality in operated cases (intubation vel tracheotomy) is according to Biggs and

Geurard 40.4% after antitoxin whereas in the pre-antitoxin days the mortality was as high as 73% (Monti). MacNaughton and Maddren's figure for the latter in 1892 is 69.5%. Here we see what a tremendous advantage patients who have received antitoxin have over those who are not treated by this means.

The season of the year seems to influence the prognosis: my own experience bears this out for whereas during the warm months we had comparatively few cases of laryngeal diphtheria, the numbers were trebled during November and December.

Treatment:

The early method of treatment, Bretonneau⁽¹¹⁾ greatly advocated the Calomel treatment; he was in the habit of giving $\frac{1}{2}$ ss every half hour to a patient of 2½ years old. He was strongly backed in his mercurial treatment by Guersant and Bouchut. Guersant also advocated bloodletting in strong children and in adults. Emetics have been (and still are) used freely. Lennox Browne⁽¹²⁾ advocates Vin. Ipecacuan. on the ground that it is a depressant and thus lessens laryngeal spasm. Sulphate of Zinc in small and frequently repeated doses has also been

recommended for a long time, but this latter drug has fallen into disrepute on account of its depressant action.

I would consider my treatment under four heads, viz:-

The Local Treatment.

The Constitutional Treatment.

The Anti-toxin Treatment.

The Operative Treatment.

The Local Treatment:

This has for its object the cleansing of the affected parts. In laryngeal diphtheria, however, this generally is very difficult as any interference often sets up a spasmodic condition of the larynx and may even cause asphyxia. We can, however, by the use of steam affect the laryngeal mucosa locally and in this way benefit the patient to a remarkable degree. Steam can be supplied, either from a steam kettle or, better, applied as in the steam-rooms of well-equipped hospitals (for a description of which see later).

Occasionally, especially in tracheotomised cases one would recommend that a layer of gauze sprinkled with some Tinct. Benzoin be placed over the steam nozzle so as to antisepticise the atmosphere of the room. This, together with hot

fomentations frequently applied to the neck in order to attempt to arrest the inflammatory process in the larynx and perhaps ice to suck, is about the only local treatment to be adopted in laryngeal diphtheria, and is often sufficient to arrest the process.

Constitutional treatment:

This is far more important than the foregoing form of treatment. Diphtheria is a disease which affects the whole system, generally by a general toxæmia, emanating from the local lesion, hence one's object must be to protect or to strengthen the system against these toxic substances. This is best done by tonic drugs administered from the very first. In the Edinburgh City Hospital one's method was to give cardiac tonics (and stimulants) from the day of admission and continue this until the danger from heart failure (i.e. the dangerous period being the first ten days or a fortnight) was at an end, then to administer a general tonic. It is the routine practice of the Hospital to put every patient suffering from diphtheria on to whisky $3/6$ vel $3\bar{i}$ and Acid Formic $\overline{w\bar{t}m\bar{l}x}$ (of a 25% solution) every four hours for the first ten days or a fortnight, and if the case be one of laryngeal diphtheria with the symptoms at all evident, the

patient got antispasmodics and expectorants as well, (Belladonna, ~~mandn~~: Ipecacuanha). Then should progress be uninterrupted after ten days the whisky is stopped and Easton Syrup (or indeed any other general tonic) is given three times daily. Should the respirations be rapid I would recommend small doses of Liq. Strychninae and if there be a tendency to haemorrhage, from the nose, small doses of Rx Adrenalin Chloride (1 in 1000) four hourly, and a plug of cotton wool soaked in the same is put into the nostril. Adrenalin chloride raises blood pressure, hence stimulates the heart and renders the dangers of cardiac failure more remote.

If there be any tendency to retching or vomiting, Brandy iced is substituted for whisky and a mustard leaf is applied to the epigastrium (occasionally recourse must be had to rectal feeding). Absolute rest must be strictly enjoined, together with the recumbent position for a fortnight or more. A very good rule is to give the patient only one pillow until three or four days after the whisky has been stopped, after which should the pulse remain good, allow a second pillow, on the first day during meals only, and the next day during several hours, so that by the end of the week after whisky is stopped the patient will have two pillows - then allow him to sit up in bed, first gradually,

propped up, and at the end of three weeks an uncomplicated case will be sitting in a chair for a short time and be walking about by the end of the month.

Sedatives are sometimes required to quieten a restless child or to quieten a troublesome cough, for this one would recommend Tinct. Camph. Co. in appropriate doses or Dover's powder if the child is able to take this. A dose of Dover immediately before intubation is sometimes useful.

Each case of laryngeal diphtheria is generally treated on its own merits. A mild case will be treated quite differently from a severe case. I will give an example of a mild straight-forward case of laryngeal diphtheria.

The patient, Bessie Crichton Miller, aet 2½ years, was out of sorts on 10th April when she complained of headache and slight sore throat.

On 12th headache much worse - throat symptoms also aggravated. Cough distinctly croupy.

13th: Patient much more croupy, voice almost absent.

On admission this morning patient is of a good colour. Throat somewhat congested and considerably injected. Both tonsils fairly extensively patched, the right one especially so, it is almost hidden by a thick white membrane. On both sides

the membrane spreads down the posterior pharyngeal wall out of sight, also in behind the uvula. The latter, however, and the soft palate, though both injected, are free from membrane. The respirations are a little laboured but there is no recession of the soft parts of the thorax. The voice is very husky. Glands - there is some sterno-mastoid enlargement. Pulse moderately fast but of good quality; is regular in rhythm and amplitude and not unduly compressible, the expansion is moderate. A swab was taken and shows good typical rods in clusters, also a few strepto- and staphylo- and diplococci, latter abundant. Temperature 100.60, Respiration 36, pulse 124 per minute. Patient on admission was given Vin. Epecac. ~~ad 2x~~ one dose, and was put on to steam. 5000 ^{units} anti-diphtheritic serum administered; twenty minutes after admission patient vomited freely and obtained some relief, was ordered Rx Whisky ~~37~~ and Acid Formic (25% solution) ~~ad 4~~ four hourly. Locally to the throat boro-glyceride and Sod. Bicarb. were ordered. Next morning temperature down to 99°, respirations also down 28, but pulse, though remaining of good quality was still rapid (128). The throat condition had not improved satisfactorily so another 3000 ^{units} anti-diphtheritic serum were administered. The laryngeal symptoms were much improved. The culture was

completely until the 18th but as the laryngeal symptoms had abated the steam was shut off on 16th. The whisky was stopped on the 26th and Easton Syrup ~~was~~ ordered t.d.s. The patient had a single pillow for the first fortnight and a second pillow for four days when she was allowed to sit up in bed for a day or two before getting on to her feet. The diet during the time that there was evidence that the membrane was still present, was milk, and slops generally. After that food nourishing and liberal. The patient made an uninterrupted recovery and she was discharged on the 15th May, after being in hospital a month and two days. Thus we see that a simple case of diphtheria of the larynx requires very little extra care or anxiety.

The Antitoxin Treatment:

After all the main stay in the treatment of diphtheria is Antitoxin. On page (3) we have seen that it was to Behring and Kiiasato that we owe the introduction of serum-therapy, that it was to them that we owe the earliest demonstrations of anti-toxin principles, that it was Behring and Wernicke, who, at the Seventh International Congress of Hygiene and Demography in London in 1891, demonstrated conclusive proofs that the blood-serum of animals which had acquired an artificial immun-

ity against diphtheria, by repeated injection of the toxins of diphtheria, if administered to susceptible animals would protect these latter from an attack of diphtheria. In 1894 Ehrlich began to use Serum manufactured from goats instead of using smaller animals and in this way he produced a serum which was very much more potent than that used formerly; he had remarkable success and it is from this time that the successful treatment of diphtheria by antitoxin dates. It was later in the same year that Katz demonstrated a series of cases treated with serum obtained from horses. This serum could be so concentrated as to necessitate a much smaller quantity relative to the potency and since then the horse has been universally adopted as the means of procuring diphtheria antitoxin.

During the winter of 1906 I had an opportunity of visiting the Burroughs Wellcome & Co's Physiological Research Laboratories at Brockwell Hall, Herne Hill, and was taken over the serum department. The horses chosen for the purpose of manufacturing the serum are young and vigorous, with no history of previous disease. These are first tested for Tuberculosis by the tuberculin test, then for glanders by the malein test and if they react to neither the horse is pronounced fit.

While I was present a horse was undergoing the tuberculin test, and another the malein test. Figures as to the percentage of glandered horses show great variation from time to time, according to the source from which the horses are obtained. Thus they have now and again a regular run of horses with a high percentage of glandered individuals; then at other times they will have a large series of horses from which they do not discard any; but roughly, about 10% of horses tested show signs of glanders and these are discarded. With regard to tubercle the main fact of interest is its rarity in horses as compared with glanders. Only very exceptionally is there any necessity to discard a horse for tuberculosis.

After the horse has been proved healthy, the toxin is injected subcutaneously in the dorsal region over the erector spinae mass. The initial dose of toxin is .01 c.c. and thereafter every third, fourth or fifth day, provided all local swelling has disappeared, each successive dose being double the preceding one. The horses are bled about a fortnight after receiving the final dose of 1000 c.c. of toxin. The whole period during which immunisation is taking place lasts from $3\frac{1}{2}$ to $4\frac{1}{2}$ months. The potency which varies in different horses is then tested. The great majority of

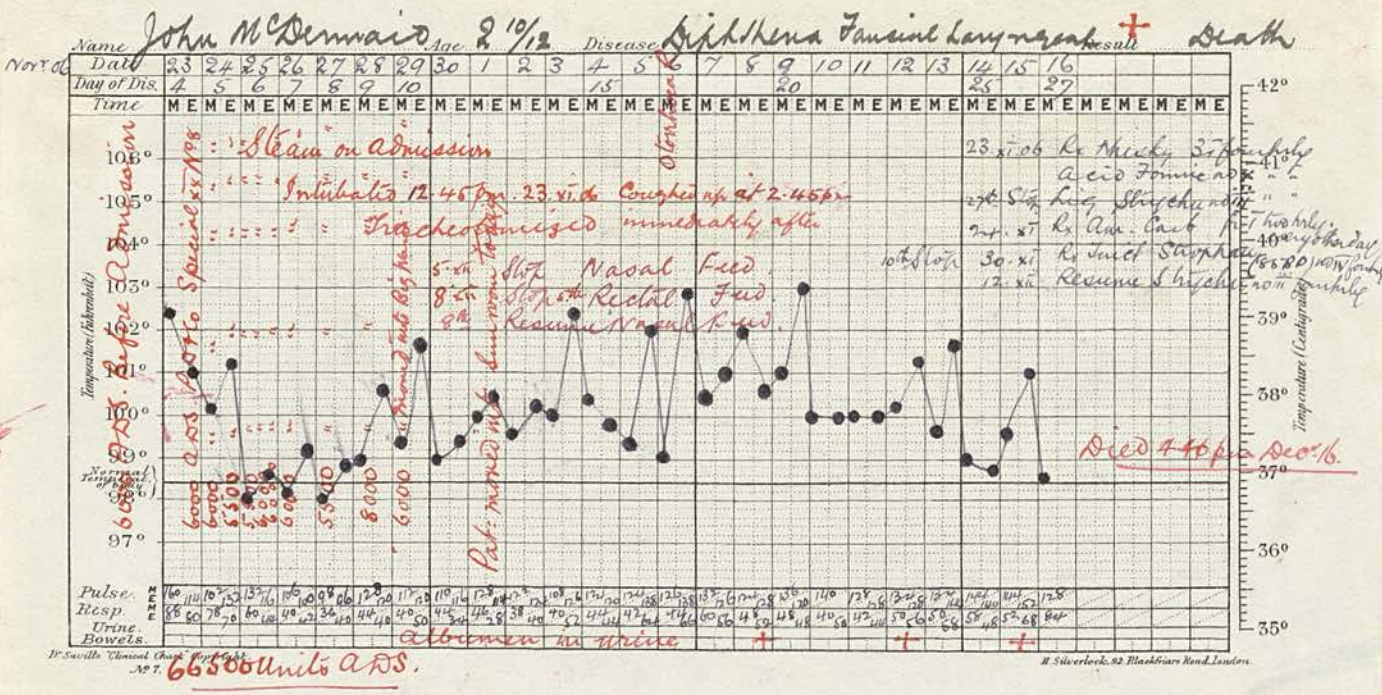
horses attain a potency of 600 units or over, at the first bleeding; but there is always a small percentage of horses which ^{does} not reach even 300 units. These latter are discarded. The first bleeding consists in taking 6 litres of blood from the jugular vein by means of a trochar and canula. In order to obtain the blood, a slit is first made through the cutaneous structures, over the jugular vein which is made to stand out, then the trochar and canula is plunged into the vein. The blood is then drawn off into large sterile flasks. The whole operation is carried out with the utmost antiseptic and aseptic precautions. What struck one was that the horses were so passive during the operation - probably because they had been accustomed to the repeated injections of toxin. The horses are not fastened up in any particular way, but are merely held by a groom by means of a halter; a few horses do resent it just a little, but not sufficiently to warrant their being tied up in any special manner.

From five to seven litres of blood are drawn off at each tapping and this is repeated during eight or nine months, after which the horse is rested for three months. The horses are well cared for and are exercised daily in order to keep them in the best condition.

The blood is allowed to stand in the "Winchesters" until clotting takes place, when the serum is syphoned off into smaller flasks by means of rubber and glass tubings. Burroughs Wellcome & Co. add a small amount of a .3% Trikressol in order to act as a preservative - it is said in no way to injure the serum. The serum is said to retain its full potency for at least one year, after which it gradually begins to deteriorate. Occasionally it happens that coagulation does not take place satisfactorily and of course if this happens the whole quantity of serum is wasted, and this in some cases would mean a great loss, the value of the serum depending upon its potency. In order, therefore, to insure that the bloodclot will separate in a satisfactory manner from the serum, a definite amount of calcium chloride is added to each "Winchester", thus rendering coagulation certain.

Dosage of Antitoxin:

The anti-diphtheritic serum should be used as early as possible in the course of the disease, and in sufficient amount to produce a distinct reaction in twelve hours; if such reaction be not apparent a second and even third dose should be administered till a definite effect is observed - not only in



the appearance of the membrane but in the condition of the patient himself. The dose in laryngeal diphtheria must always be relatively larger than in faucial conditions, because of the greater liability for the disease to spread downwards, when situated in the larynx, and cause either laryngeal or pulmonary dyspnoea. The smallest dose of anti-toxin that can with safety be given to a case of laryngitis which has been pronounced to be diphtheritic is 4000 units of the concentrated or (Special) strength, and while it is seldom that so small a dose is given, there is practically no limit to the amount one can give. I myself have administered up to 66500 units in a case of laryngeal diphtheria.

John MacDermaid: aet 2 ¹⁰/₁₂ years.

Admitted 23rd November 1906. Died 16th December, 1906. Been ill since 19th November. Admitted 23rd. On admission child comatose, much cyanosed and breathing very heavily, great deal of recession of soft parts, accompanied by marked action of alae-nasi. The pulse is running and is very readily compressible; respirations are small, laboured and rapid. Expression is very anxious, the patient is restless. Some herpetic eruption on lips. Fauces somewhat congested, slight grey-ness, no definite membrane to be seen. Tonsils ?

hidden by dirty mucous. Voice nil. Slight enlargement of submaxillary glands. Patient was intubated on arrival (12-45 p.m.) was slightly relieved and on being freely stimulated fell asleep; first, however, coughing pretty freely and expelling small fragments of membrane through tube. (Had had 6000 units anti-diphtheritic serum immediately before admission). The tube was coughed up at 2-45 p.m. and as the recession was still very marked and child much distressed and since intubation had not given much relief I tracheotomized patient at once. The operation was somewhat lengthy, there was very little coughing on trachea being opened, small shreds of membrane were removed, tube in situ, freely stimulated, hypo: strophanthin, 6000 units anti-diphtheritic serum given, got to bed, hot bottles, fomentations (praecordia) steam, and patient fell asleep. Swab. Good rods diplo+, staphylo-cocci. Culture is positive.

24th: Only moderate night. Respirations still keep up. Pulse and Temperature both down a little, former more steady. 4 a.m. 6000 units anti-diphtheritic serum administered, immediately after patient collapsed and was with difficulty brought round, Hypo Ether and brandy, fomentations (praecordia). Tube became blocked and was immediately removed, a small fragment of membrane was found at foot. Tube was cleaned, reinserted and after much coughing a fair sized

piece of blood-stained membrane was expelled. Patient slept fairly well after this, colour much improved.

25th: Patient had a very restless night, breathing during first part was very laboured with much indrawing; tube was much blocked at 1-15 a.m., was removed and patient coughed great deal of membrane through the wound; the tube was cleaned and re-inserted; membrane again blocked the tube, former was with much difficulty removed (feather). Patient was much collapsed and had to be freely stimulated. Hypo first, ether, then strychnine. Settled down after this and slept well.

28th: Until this morning patient has improved steadily under free stimulation and free administration of antitoxin, giving himself every chance, taking nasal feeds etc. well; sleeps well; has continued to cough up at frequent intervals, and with aid of feather and sod. bicarb. fairly large pieces of membrane, generally tinged with blood. This morning patient is less lively and is more listless; temperature and pulse are both rising; respirations, however, remain about 40. Pulse has gone up a good deal, the colour, too, is less good. 8000 ^{units} anti-diphtheritic serum again administered. Towards evening the patient was much improved, has slept well since the last dose of anti-diphtheritic serum. Pulse much more steady.

Child takes nasal feeds well. Still coughing up from time to time pieces of membrane. Thus far patient has had anti-diphtheritic serum administered at least once every 24 hours.

29th: Temperature and respirations rising: patient restless during night. Is inclined to be fretful. 6000 units anti-diphtheritic serum again administered.

30th: Good night, after the 6000 antitoxin administered at 7 p.m. Slept well, pulse, temperature and respirations all much improved.

4th: Sun room to-day.

5th: Thus far progress has been maintained. This, however, has been a most unfortunate day for the boy. Yesterday there was some hitch about the nasal feed, the nasal tube refused to go down, and patient was rectal fed instead. This morning Sister took the feeding in hand, the tube was passed, as she thought, satisfactorily, but by some unaccountable and altogether inexplicable means the contents of the nasal feed, on the tube being withdrawn, were forced through the tracheal tube in fits of spasmodic coughing, showing clearly that the milk etc. had gone down trachea instead of down oesophagus. Child was naturally very much collapsed, the temperature, pulse and respirations all up this evening. Child looks real bad.

6th: Patient had a bad night. Severe spasmodic fits of coughing all through; respirations up all day. Otorrhoea right ear (culture negative)

10th: Child going downhill steadily.

12th: Temperature and pulse both somewhat improved during the past two days.

15th: Child very weak, has lost ground steadily, refusing food since yesterday, takes nothing but whisky and water.

16th: Died at 4-40 p.m. without a struggle, refusing to take anything but whisky by mouth unto the last.

The interesting features of this case is the undisputed benefit the patient derived from almost every dose of antitoxin. It will be noticed that with very few exceptions the temperature and generally the pulse came down after the administration of anti-diphtheritic serum. Another interesting fact is the gradual but steady fall in the rate of the respirations especially seen at the beginning of the patient's stay in Hospital, until the 5th, when patient had that unfortunate nasal feed. After that it was worse than hopeless to look for a favourable termination to the case. The wonder is the boy lasted so long for on the admission of the case it was considered to be hopeless. However, as improvement was maintained we became more

hopeful of ultimately pulling the patient through, and in all probability the case would not have had a fatal termination had the nasal feed on the 5th proved successful.

Total dose of antitoxin, 66500 units.

What is the best method to adopt in administering the antitoxin ?

I would strongly advise that not too large a dose be given at a time. From 6000 to 8000 units administered every twelve hours so long as is required would be the ideal way of giving the serum. In this way you have a continuous action, and the patient is always under the influence of the antitoxin, rather than give 16000 to 20000 units as one formerly did.

There is a definite amount of toxin free in the system at a given time, this can be more or less judged by the condition of the patient's respiration, pulse, appearance and physical depression, and one's object must be to give sufficient antitoxin that would neutralise the toxin. If much antitoxin in excess be given what happens to that not used up in neutralizing the toxin ? A little of it is probably voided in the urine, but some of it goes to form anti-immune bodies, which act as toxins in the system, (Ainley Walker⁽¹³⁾.)

We read in the Clinical Journal, "One other factor of prime importance in the serum treatment of disease has been discovered recently, the fact that an excess of immune serum can work serious and even fatal injury Neisser and Wechsberg found that on injecting animals with too much serum they died as certainly as if too little immune serum had been given in the specific treatment of infections. This, on investigation, proved to be the result of a deficiency of complement occasioned by the excess of immune serum."

The ideal way, therefore, in my opinion to give the anti-diphtheritic serum, would be to administer moderately large doses of the concentrated serum frequently repeated, until a sufficient quantity had been given, for example 6000 to 8000 units repeated in from eight to twelve hours so long as is necessary irrespective of age. (These moderately big doses refer to cases of laryngeal diphtheria).

It must be remembered that the earlier the anti-toxin is administered the less is required and the better is the prognosis. In faucial cases:-

If administered on:-

1st day of the disease	the mortality is	3.5%
2nd " " " " " "	" "	8%
3rd " " " " " "	" "	12.8%
4th " " " " " "	" "	23.6%
5th " " " " " "	" "	35%

(Biggs and Geurard's table).

[illegible]

In the 70 laryngeal cases I had, the following is the percentage of deaths. If admitted on:-

1st day of the disease	the mortality was	0%
2nd " " " " " "	" "	12%
3rd " " " " " "	" "	12.5%
4th " " " " " "	" "	28.5%
5th " " " " " "	" "	33.3%

Sometimes it happens that a patient becomes thoroughly poisoned and though he comes under treatment comparatively early he shows no response whatever to the administration of antitoxin. The following case, an extremely toxic one, illustrates this condition very clearly.

Mary Ford: aet 9 years.

Took ill on 23rd. Throat noticed on 24th. Admission on the 29th. The patient is thoroughly poisoned looking; she is only semi-conscious, dusky look, pupils much dilated, no reaction to light: marked internal strabismus of right eye (Mother says) it has increased very much since last night. Pulse is markedly irregular, but of moderately good expansion. Respirations are of sighing nature, deep and not laboured. Slightly croupy cough, very slight recession of soft parts. Patient lies with mouth wide open, tongue thick, swollen, is protruding, the eyes are turned up so as to expose the whites only - occasionally she appears to want to control her eyes. There is some

rolling of the head from side to side. The tongue is thinly furred, the papillae are a little prominent. Fauces are slightly congested, slight grey-ness on tonsillar and pharyngeal surfaces, small patch of greyish white membrane on posterior pharyngeal wall. Small submaxillary glands. Swab. Mixed rods, diplo- and staphylo-cocci. Culture positive.

1st January 1907. Patient has been restless since admission, mouth remains constantly open, the tongue protruding, eyes and head always rolling from side to side, pupils are widely dilated, colour always dusky. Child has never been really conscious, occasionally she cries out and sometimes lies muttering, also occasionally she picks at her clothes. Patient occasionally takes a peculiar turn, not unlike a convulsive fit, twitching of right side of face and body, right arm becoming rigid.

2nd January 1907. Very restless night lying awake and in muttering delirium. Pulse has never been good, is much worse to-night.

4 a.m. Paraldehyde ^{3℥}. . No sleep, pulse too poor to administer more. Patient gradually sinking, died at 10 a.m.

This patient was so extremely poisoned as to show no reaction to the administration of antitoxin.
units
10000 anti-diphtheritic serum given.

The benefits of antitoxin have over and over been definitely and conclusively proved and it does not permit of my going into statistics in a work such as this.

There are still quite a large number of medical men who maintain that antitoxin has no beneficial effects on the diphtheritic process, and who do not employ the serum treatment. They maintain that the apparent success of this treatment is due to the fact that cases that would formerly have passed as "sore throat" are now classed as diphtheria, and that this inclusion of very mild cases has apparently reduced the death rate. But there is absolutely no doubt that this treatment is the most essential of all for diphtheria and one would be inclined to regard it as criminal to stand by a bad case of diphtheria without giving the patient the benefit of the antitoxin. For the successful treatment of diphtheria by antitoxin the patient must be brought under its influence as early as possible, especially is this the case in laryngeal cases of diphtheria. As has been stated, the age of the patient does not influence the dosage of antitoxin, the dosage being irrespective of age. On the other hand, as we have seen, age greatly influences the death rate for we find that diphtheria, and very especially laryngeal diphtheria is a very fatal malady in young children,

about 35% of all children under two years who take diphtheria, and who receive the antitoxin, die of the disease, while according to Baginsky 63% of children under two years who take diphtheria die if not submitted to the antitoxin treatment. While these figures refer to all cases of diphtheria we find that the death rate in laryngeal diphtheria is much higher.

Restricting ourselves to the benefits of antitoxin in laryngeal cases, we find that fewer cases require operative interference than formerly, and secondly we see that cases operated on do so very much better after the antitoxin treatment than was the case before the introduction of antitoxin.

Macnaughton and Maddren⁽¹⁴⁾ (1892) collected the results of 5546 cases of intubation with a death rate of 69.5%. They state here that the mortality of the intubated cases at present has been reduced to 27%, while the mortality of laryngeal diphtheria as a whole is 21%.

Clubbe⁽¹⁵⁾ reports on 300 laryngeal cases treated with antitoxin, with 129 tracheotomies and a death rate of 20%, and 300 cases treated without antitoxin with 199 tracheotomies and 158 deaths or 52.7%. Here we see well illustrated the two facts stated above, namely, a smaller number requiring operation and a smaller mortality of operated cases,

after antitoxin. The Investigating Committee of the Clinical Society of London gives a report on the analysis of the tracheotomy cases reported by the Metropolitan Asylums Board of London:- "In 1894 there were over 1800 cases with 73% of deaths, in 1896 with antitoxin 137 cases with a mortality of 43.7%". Here we see an enormous reduction on the number of cases requiring operation. The same Committee report in 1898 on 75 cases tracheotomized, with antitoxin treatment and 27 deaths or 36% as compared with a previous mortality of 71.6% without antitoxin.

The 75 cases above mentioned have been analysed as follows:-

Treated from the 1st day to 3rd day,
31 cases, 5 deaths, 16.1%.

Treated from 4th to 6th day, 27 cases,
11 deaths, 40.7%.

On and after the 7th day, 17 cases,
11 deaths, 64.7%.

Here again we see the necessity of early treatment.

In 60 cases of Laryngeal Diphtheria (one case being excluded as it arrived moribund and did not receive antitoxin) the average dose of antitoxin per case was 13183.3 units. The least quantity given to one patient was 4000 units, while the most that one patient received was 66500 units.

In the nine cases in which no Klebs-Löffler Bacilli were found and which have consequently been classed as laryngitis, the average dose received was 7500 units; the smallest dose given to a patient was 3000 units, whilst the maximum dose given was 11000 units.

I have analysed my 70 as follows:-

How many days ill before admission.	Number of cases	Number operated upon	Total Deaths	% of Deaths	Average dose of antitoxin	Average number of days in Hospital.
1 and 2 days	8	2	1	8.3%	5875 units	26.5
3 and 4 days	25	13	7	28%	15560 "	28.7
5 and 6 days	15	11	4	26.6%	18266.6 "	33.6
7 and 8 days	7	3	0	0%	13142.8 "	40
10 days	1	1	1	100%	10000 "	56
14 days	1	1	1	100%	10500 "	18 hours
Doubtful and indefinite history	13	2	0	0%	12500 "	28 days
Total	70	33	14	20%	12263.5 "	

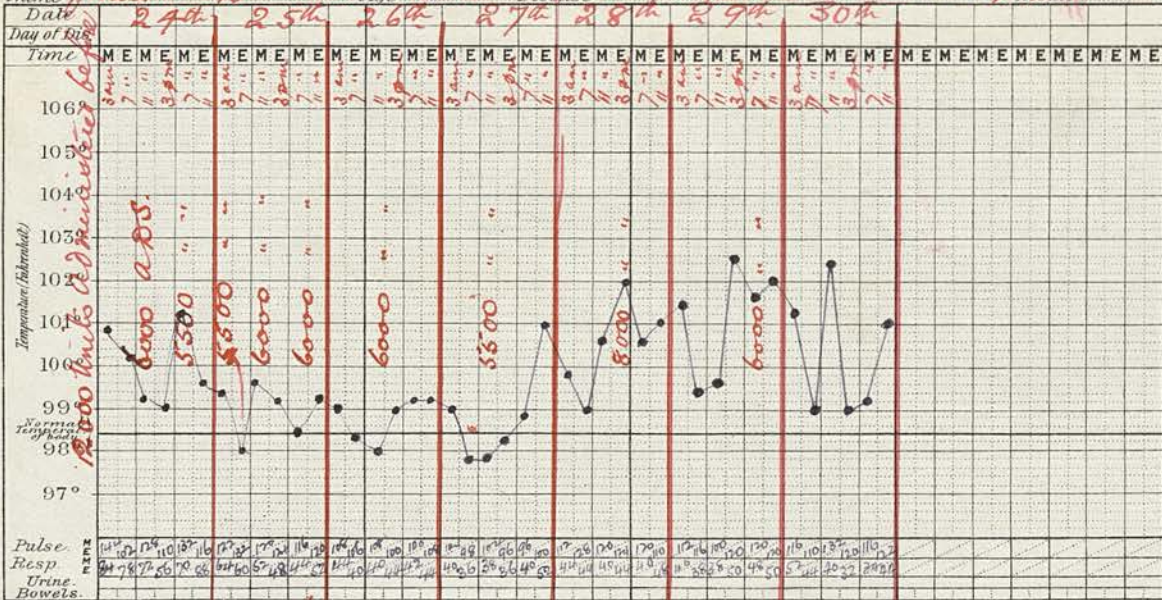
Effects of Antitoxin on Paralysis.

Some authorities maintain that paralysis is of a more frequent occurrence after antitoxin than formerly. There may be some truth in this statement in so far as you more frequently come across paralysis now than in the pre-antitoxin days. This, however, is in all probability due not to the antitoxin but to the fact that fewer cases succumb now than formerly and in those cases which do terminate fatally, life is much more prolonged, giving the paralysis more time to develop. Taking statistics, again deribed from the Clinical Society of London 1898 regarding paralysis:- "In 633 cases treated with antitoxin there were 145 cases slight, in 35 severe. In another series of cases treated without antitoxin, paralysis occurred in only 10.8%. The mortality, however, among the cases treated with antitoxin was 8.9% and 12.2% in those not so treated."

The effects of antitoxin on the occurrence of albuminuria and nephritis:

Antitoxin does seem to influence the occurrence of albumen in the urine for according to the Metropolitan Asylums Board, London, in the cases not treated with antitoxin 24% had albuminuria, while after antitoxin 60% showed some albumen present.

Name *John MacDonaid* Age *2 1/2* Disease *Diphtheria Tonsillar Laryngeal*



Nephritis, on the other hand, was of less frequent occurrence with antitoxin in the ratio 1.2% nephritis without antitoxin to .5% with serum treatment. Here we see that the serum treatment has a favourable action on the more serious kidney lesion, namely, nephritis, while a transient albuminuria is less readily met with in cases not subjected to the antitoxin treatment.

The general effects of the antitoxin on the patient:

After inoculation there is a slight redness of the cutaneous structures, especially at the site of inoculation. The pulse is momentarily accelerated. Some maintain that there is a rise of temperature of from one to two degrees, coming on four or five hours after injection. I certainly have not found this to be the case, except perhaps in a very limited number of cases, on the contrary in cases where there has been much temperature one very generally noticed a slight fall after the administration of the serum (see John Macdermaid's four hourly chart opposite). I have had opportunity of coming to the conclusion however, that the antitoxin acts as a diuretic, a soporific and a general sedative during several hours after injection. The patient generally falls into a sound sleep almost immediately after the administration of the antitoxin. I have seen

neither of these facts stated elsewhere.

On the pseudo-membrane its effects are very marked; within a few hours of administration of antitoxin the membrane becomes blanched, the mucosa round about appears more congested, later on the membrane loosens at the edges and begins to curl up, detaching itself spontaneously, either piecemeal or en masse.

In laryngeal cases the serum retards or completely checks the diphtheritic process, so as to reduce the need of operative interference by over one half. Also that after operation the tracheotomy or intubation tube can be removed much sooner than had no serum been administered.

The patient on the whole looks better, feels better (i.e. much less depressed) and is better. The pulse is certainly somewhat accelerated immediately after injection, whether due to the anticipation, on the part of the patient, of pain with the injection or to positive fear for the "needle" as one has seen quite a number of patients manifest, or whether to some direct effect of the serum one is not prepared to say. But this acceleration of the pulse is only momentary (cf. John MacDermoid's four hourly chart) as almost immediately (i.e. within an hour after inoculation) the pulse is less unsteady and less rapid.

Lastly and chiefly the antitoxin neutralises the toxins present in the system at the time of inoculation.

Does antitoxin produce any bad effects on the patient; and if so, what are they ? The administration of antitoxin is occasionally the cause of more or less unpleasant symptoms, the commonest of these probably is a rash, erythematous or urticarial in character, (more rarely it is scarlatini-form or morbiliform) which makes its appearance in from one to twenty one days after the administration of the antitoxin. The itching produced sometimes is unbearable, but there are no constitutional symptoms (very rarely one sees distressing symptoms such as severe pain in the joints and muscles of the whole body.) ⁽¹⁶⁾ Seward describes two cases of syncope following closely upon the injection. Esch-⁽¹⁷⁾erich quotes the case of the son of Professor Langerhan, who died suddenly shortly after receiving the antitoxin, and on post-mortem it was found that the child had a thymus gland weighing 15 grammes.

Though these untoward symptoms and conditions seldom arise one sometimes meets with joint pains, and in a few cases actual arthritis.

The Surgical Aspect of the Treatment of Laryngeal Diphtheria:

I will endeavour to discuss tracheotomy first because it is much the older method of procedure.

History:

The operation of tracheotomy is said to be of ancient origin for Asclepiades of Bithynia, who was a contemporary of Cicero, is said to have been the author of the operation and he is said to have saved a great many lives "who were in danger of perishing from suffocation" (Sprengel).⁽¹⁸⁾

From this time it seems to have been dropped until the operation was revived by Benivieni of Florence⁽¹⁹⁾ who adopted it as a method of relieving dyspnoea. From this time it became almost naturalised into surgery; but it was not until the middle of the eighteenth century that it was universally practised.

In 1694 a Dutch surgeon, Dekker⁽²⁰⁾ by name (Parker) introduced a "tracheotome", an instrument after the style of the trochar and canula, this was plunged into the trachea and in this way the dyspnoea was relieved. Tubes of various kinds were also used, but the double tube we owe to Dr George Martin in 1730, for it was he who first adopted it. Since then it has been almost universally used. We also owe a great deal to

Trousseau who improved the operation, and the method of after treatment.

The question arises, when will you do tracheotomy ?

(1) When you have reason to suspect that the membrane extends lower down than the larynx, causing obstruction to respiration.

(2) In every case where intubation has failed to give relief, such as in extreme oedema of the glottis.

(3) Where operation is necessary, and the operator has not got the intubating instruments.

(4) In all private cases where operation is necessary (i.e. cases treated not in hospital or when a case cannot constantly be under the immediate care of the doctor; because should the patient be intubated, and when the doctor is away, cough up the tube, the nurse would be unable to replace the tube and before help could be forthcoming the patient would in all probability be dead; whereas had the child been tracheotomized, the inner tube could readily be removed by the nurse, cleaned out and replaced.)

(5) Secondary to intubation in order to break the patient from the intubation habit. It generally happens, however, that when a patient has first been intubated and then tracheotomized to get

rid of the intubation tube that eventually the child will need to be reintubated in order to get rid of the tracheotomy tube. I have lately seen a case in which this happened.

The indications for operation are:- a progressive dyspnoea, increasing restlessness, and exhaustion, a failing pulse and recession of the soft parts of the thorax to any marked degree. Never hesitate until too late. An anaesthetic is generally employed, but it occasionally happens that the patient is in extremis and under these circumstances one is justified in doing the operation without anaesthesia - thus saving unnecessary delay. In an emergency all that is necessary is a sharp knife, an assistant to steady the patient and some means of keeping the trachea patent when once opened. One essential is that the incision must be in the middle line and that the patient's head must be thrown well back, this latter means is obtained by placing a narrow sand pillow below the shoulders of the patient, with the head over the end of the table. The trachea must not be opened until the cartilaginous rings are laid bare, then when it is opened the operator must stand well aside so as not to let the patient splutter over him. Sometimes the patient is in such extremes that the knife must be plunged into the steadied trachea without a minute dissection

of the structures. A detailed account of the operation would be out of place in an essay such as this. Parker in the preface to his book on "Tracheotomy in Laryngeal Diphtheria" says: "The presence of membrane in the trachea in a fatal case of membranous laryngitis, after tracheotomy must be regarded as evidence of the want of due care on the part of the surgeon in charge, just as much as would the presence of a piece of gut in the inguinal canal after herniotomy, or a calculus in the bladder after the operation of lithotomy." This in my opinion is expecting rather too much from the surgeon, as anyone who has had to perform the operation of tracheotomy in laryngeal diphtheria will know. There is nothing so difficult as to cleanse the trachea below the tracheotomy wound of membrane.

After the operation, the patient must be put into a room with a warmed atmosphere and with steam turned slightly on. After expelling as much of the blood and mucous by coughing through the tube as is possible the patient must be encouraged to sleep. When the patient is being fed I would strongly advise that feeding per vias naturales be absolutely discarded and the patient be fed by means of a nasal tube. At first the patient will resent this manner of being fed but he will soon accustom himself to it. This minimises the dangers of

broncho-pneumonia, which are very imminent. Great care must, therefore, be taken to insure that the tube has entered the oesophagus and the stomach before the liquid are administered, and before the liquid foods have been poured into the canula which has been attached to the tube a little clean cold water should first be poured down, then if the tube has by any chance found its way into the trachea, and there curled up, a spasmodic coughing will be set up and a check can at once be applied.

Complications of Tracheotomy:

Parker⁽²¹⁾ sums up the complications of Tracheotomy:-

"(1) Those which affect the wound (extra-tracheal).

(2) Those which concern the trachea itself, (intra-tracheal)."

I give as a third:-

(3) Those which affect the lungs, diphtheritic broncho-pneumonia.

Among the former we get inflammatory oedema of the neck, one occasionally sees an inflammation of the cellular tissues of the neck after tracheotomy, but fortunately this is rare. The loose cellular tissue in front of the trachea is a suitable soil for the development of cellulitis. I have seen one case where quite an extensive

inflammatory condition did develop. Although wound diphtheria is said to be a complication, it is remarkably rare. I have not seen a single case of this.

Unhealthy granulating tissue is apt to form round the wound: in this case a touch with copper sulphate will generally suffice: of this condition I have seen one case.

Of the complications which concern the trachea itself granulating sores where the inner extremity of the tube comes in contact with the tracheal mucosa are not very uncommon and occasionally give rise to much trouble (see the following case).

Marie Jackson: aet 1⁵/12 years. Admitted 23rd April, 1906. Died 20th June, 1906.

Took ill on 13th April. Croupy 15th.

20th: Took to bed and put on steam. Has had measles.

Admitted 2 p.m. 23rd. Patient was markedly croupy and much cyanosed, neck vessels very turgid, lips especially were blue. Respirations were fast, shallow and much laboured, indrawing only moderately marked, especially seen in epigastrium, and at the root of the neck patient appeared to be suffering from broncho-pneumonia. Pulse is rapid and thready, hardly perceptible. Patient was put on to steam immediately on admission, was freely stimulated, two

drachms hot whisky, also Vin. Ipecac. minim \overline{XX} (one dose). Pulse steadied a little, but half an hour after patient became semi-collapsed and was intubated 2-30 p.m. (No. 2 O'Dwyer). Intubation afforded full relief but patient coughed a great deal after, spasmodic in nature, colour however improved. Pulse continued bad, but by means of stimulants it was steadied, though it remained fast (140). Some little time after the operation patient vomited a fair quantity of greenish fluid, no membrane, however, had been expelled, either during the coughing bouts or with the vomit. The tonsils and pharyngeal wall though somewhat congested and injected were as far as could be ascertained, free from membrane, ditto palate and uvula.

Voice was markedly croupy, cough (previous to intubation) was harsh and brassy. Glandular enlargement was only moderately marked. There was no rash. Patient is well nourished.

Swab was taken immediately before intubation. Result, strepto-cocci, few indefinite, and staphylococci, also small ovoids, no rods. Culture negative on two succeeding days.

The administration of antitoxin was delayed until 7 p.m. when 5000 units were administered into cellular tissues of the back. This evening temperature has gone up from 100.1° on admission to 101.2°.

Pulse also is more rapid (148) and respirations somewhat higher 48 (40 on admission) but much less laboured; quality of pulse, too, has improved.

24th April: Patient had a fairly good night. She still has occasional fits of spasmodic coughing - no membrane expelled. Is inclined to be a little puffy (no specimen of urine has as yet been obtained) Temperature, pulse and respirations still keep up. Pulse inclined to intermit.

At 1 p.m. temperature had risen to 102.80. Pulse 150, respirations 50. But since then temperature has fallen steadily - respirations and pulse also show some improvement. She has taken nourishment and stimulant well, by means of nasal tube.

26th: Good night, temperature 100°, pulse 128, respirations 48, colour much better.

Extubated at 11-50 a.m. We were compelled to reintubate at 12.5 p.m. as patient's breathing became markedly laboured and pulse and colour went off considerably. Relief was complete and immediate. Pulse good, quiet day.

28th: Respirations again up to 40 this morning, in spite of a good night. Patient was extubated at 11-40 a.m. Respiratory embarrassment very marked, the colour and pulse went off very considerably. Pulse became bad after the operation, the patient was freely stimulated and rallied. Respirations

are up again 44. (Respirations very fluctuating all through) Patient was re-intubated in five minutes.

30th: Temperature subnormal last two days. Patient extubated at 11-45 a.m. Respirations became markedly embarrassed and pulse went off: she was re-intubated at 11-55 a.m. Relief was complete and immediate.

1st May: Had good night. Pulse and respirations settling well. Patient this morning at 10-45 coughed the intubation tube up. It was necessary to reintubate her immediately, the relief was complete. The pulse and respirations are fair, more steady than yesterday. Patient coughed the tube up again at 1 p.m. and as the respirations became much embarrassed it was deemed advisable to perform Tracheotomy at 1-15 p.m. Some difficulty was experienced in inserting the Tracheotomy tube: the patient also lost a fair amount of blood but was very much relieved by the operation. Patient does not seem to have inspired much blood. No membrane was discovered at the operation. Towards evening the respirations and pulse both went up a little but the temperature still keeps down.

3rd: Sleeps quietly during intervals between the fits of spasmodic coughing. During these coughing bouts patient gets rid of a good deal of mucoid matter, stained with blood.

This morning at 9 the temperature had dropped to 99°0, but at 1 p.m. it was up to 122°0. Patient has maintained her colour well. Up to now patient has been kept entirely on nasal feeding, but this afternoon small sips of stimulant, also milk, were taken quite well by the mouth.

5th: Patient keeps better in spite of the fluctuations in her respirations. To-day the tracheotomy tube was covered by means of a soak of several layers of gauze, fairly firmly, during six hours, the child suffering no very great inconvenience, although there was some degree of indrawing.

6th: Good night. This morning the tube was removed for a few minutes and wound firmly occluded, child however unable to breathe per vias naturales at all, and coughed only with the greatest difficulty, no vocal element in the cough at all. Tube re-introduced in ten minutes. Respirations and pulse much improved; former down to 36.

8th: Patient's appearance, also pulse and respirations much improved. Had good night, is taking stimulant and nourishment well, still by means of nasal tube.

At 5-40 p.m. this evening patient was re-intubated, the tracheotomy tube removed, and the wound in the neck closed with a swab. The respirations and pulse remained fairly good. The patient, however,

resents the intubation tube and coughs a good deal. Some bloody mucous is all the result.

9th: She has had a restless night - salivated very fully - temperature up a little, respirations and pulse, however, remain good. Intubation tube removed at 11-30 a.m. and tracheotomy tube re-inserted as respirations were at once difficult. Relief immediate and complete.

27th May: Tube was taken out and changed but had to be replaced in less than half an hour, the breathing was carried out entirely by the throat hole - as this contracted, the colour faded, and the tube had to be replaced. A nasty tracheal discharge has been coming away freely by the wound for several days - wound looks healthy and is neat.

15th June: The wound is still discharging some sticky, semi-purulent mucous.

Several attempts to make her breathe through the normal passages have failed. The tube was removed at 6 p.m. and patient was intubated once more.

16th: Intubation tube removed to replace the tracheal one - wound found closed and had to be enlarged. The patient was reintubated in the evening.

17th: Tubes changed, i.e. tracheal tube replaced. Patient is not so well to-day - very foul discharge escapes from the tube.

18th: Patient was intubated this morning, seemed more settled. Same on the 19th, until the evening when she became very restless and on the 20th coughed the tube up and died before it could be replaced. Cardiac failure secondary to a broncho-pneumonia.

21st: Post mortem: Septic pneumonia in right middle lobe. Ulceration of the laryngeal box and superficial inflammation of whole length of tubes together with granulating sores of larynx; mucopurulent discharge up all main bronchi, chiefly from right middle lobe.

Total dose 10000 units of antitoxin.

Cicatricial narrowing is occasionally met with and gives great trouble.

Then sometimes one experiences great difficulty in finally removing the tube. Whether this is due to nervousness on the part of the patient or to a genuine difficulty on the part of the patient to breathe properly is not certain. It, however, is a most unfortunate condition when it does exist. (cf. case Marie Jackson).

The Dangers of Tracheotomy:

(1) That during the operation the patient may cease to breathe. Should this happen, hasten the opening of the trachea and then resort to artificial respiration.

(2) Excessive haemorrhage into the trachea, and thence to lungs, causing considerable distress, and the dangers of broncho-pneumonia.

(3) Emphysema is a danger (though fortunately not very frequently seen) especially if the wound extends far down.

(4) Inserting the tube between the tracheal wall and a membranous cast.

The Objections to Tracheotomy:

(1) Parents of children often object to the idea of allowing a cutting operation.

(2) The presence of the scar.

(3) The delay as compared with intubation.

(4) As a rule the convalescence is longer than in intubation.

(5) Requires much more nursing than does intubation.

(6) Requires an anaesthetic whereas intubation does not.

(7) The dangers on a whole are more pronounced than in intubation.

Tables of Tracheotomized Cases:Non-fatal cases:

Number.	Average dose of Anti-diphtheritic serum.	Average duration in Hospital.
3 = 50%	7000 units	39.6 days
<u>Fatal Cases:</u>		
3 = 50%	15666.6 units	4 days.

Intubation of the Larynx:

According to Ker⁽²²⁾ "The operation of intubation consists in the introduction through the mouth of a tube provided with a collar which, when the tube is in position, lies upon the vocal cords."

A Short History of Intubation:

It was in the year 1858 that Bouchut first practised catheterizing the larynx instead of tracheotomizing it, in cases of laryngeal diphtheria causing obstruction. Later on Monti also adopted this method with an encouraging amount of success. Both these eminent men had, however, to stand the ridicule of their contemporaries. This was the first step to intubation now so successfully practised.

In Miles and Thompson⁽²³⁾ we read: "a simple gum elastic catheter with a terminal opening (as suggested by MacEwan and Annandale) is equally efficient" if the intubation apparatus is not handy, when discussing intubation by means of the O'Dwyer Tubes. So we see that catheterizing the larynx has been practised and with a moderate amount of success for many years. It is to O'Dwyer of the New York Foundling Hospital, however, that we owe intubation in its successful practice, as seen at the present time.

Quoting from Nothnagel's Encyclopaedia of Practical Medicine, we read: "The terrible results of tracheotomy at this institution (the New York Foundling Hospital) may be said to be responsible for intubation as we now know it. From 1869 to 1880 no cases of tracheotomy performed for diphtheritic croup recovered." From this we see with what dread the surgeons must have practised tracheotomy and how they would welcome some method which could replace it. The first intubation tube tried, 1882, was a bivalve but this was found most unsuitable, as a means of keeping the tube open was found difficult; either it was too powerful and lacerated the parts, or it was too weak and gave no benefit to the wearer. From this other tubes were made, tried and discarded as useless, and in 1885 O'Dwyer

took the question into consideration. After making several tubes which he tried and set aside he at last made what to his mind is a satisfactory tube. His latest pattern reaches when in situ to within an inch of the bifurcation of the trachea. The lumen is elliptic; viewed from the front we see a "retaining swell", while viewed laterally the lines are perfectly straight. The tube has a sharp lateral constriction below the head, while the head itself is irregularly oval. The edges are rounded off and blunt. The tubes are made in seven sizes (or more) adapting them to the age of the patient. For inserting the tube you require an obturator which is fitted to the introducer. An extractor is also supplied but this is not recommended for use in Edinburgh, a banjo D. String tied into the hole on the left side of the head of the tube, being used to remove the tube instead.

The Indications for Intubation:

Our best guide is the condition of the patient. Should the patient appear to be markedly dyspnoeic, and yet have a good pulse, it is not necessarily a call for intubation. For very often (in cases where the pulse remains good) the breathing improves rapidly after the patient has been put on to steam and has received an initial dose of antitoxin. One

is at present quite justified, where one has all the facilities of a modern infectious diseases Hospital with its many advantages, in waiting for marked symptoms such as a failing pulse, together with a progressive dyspnoea and increased restlessness of the patient. Before there is a call for intubation, therefore, the patient will have suffered from some degree of dyspnoea, recession of the soft parts of the thorax, activity of the extra-ordinary muscles of respiration, activity of the alae nasi and a certain degree of lividity, together with increasing listlessness. For as has been stated, the undoubted and indisputed benefits of antitoxin and the facilities one has in a modern hospital in the management of a copious supply of steam enables one to feel quite justified in delaying operative interference in the hope that operation will be obviated altogether.

The method of procedure:

The child is pinned in a light blanket, firmly yet lightly, so as not to embarrass respirations. The patient is then brought to the right side of the bed, always in the dorsal position and the gag inserted, on the left side, the child meanwhile being firmly held, a nurse steadying the head, while a second holds the patient's body. The

gag must be put well back between the molar teeth (if these be present, if not as far back as possible) care must be taken not to include the tongue. The gag must then be screwed up so as to open the patient's mouth fairly widely, kept pressed well against the cheek, thus keeping the inner portion in position. I will not enter into the operation itself as unfortunately one gets no personal experience in the performance of it. A characteristic rush of air, harsh cough and a free spitting on the part of the patient together with the relief of the dyspnoea (generally) indicate that the tube is in the larynx. Before inserting the tube the hole on the left side of the head of the tube, must be threaded with a banjo "D" string. After the tube is in situ the string is secured by means of a piece of adhesive plaster to the left cheek. I would strongly recommend that the string be left in place as the tube can then very readily be removed by a nurse should occasion arise, whereas she may not be able to enucleate or extubate it were the string absent. Secondly, there is no time lost in extubating and little or no danger of damaging the parts, whereas there is great danger and no little difficulty in extubating by means of an extractor. Thirdly, the tube can be readily withdrawn when the string is in situ by the most inexperienced person without

any difficulty. The patient very soon adapts himself to the presence of the wire in the mouth and it inconveniences him but little. Certain precautions are always necessary when the string is left in place: the hands of the patient must be secured in some way; but I would strongly condemn the practice of tying the patient's hands to the sides of the cot. In the Edinburgh City Hospital the method there employed is to make elbow splints of corrugated cardboard, lined with surgeon's lint so as to avoid chafing; the splints are then made into the form of tubes and slipped on. They are secured by tapes behind the neck, the tapes passing round the neck over the shoulders. Then a small woollen jacket is put on to the child with the splints in the sleeves. In this way a child can use his hands freely, yet he is wholly unable to bend his elbows and thus cannot pull out the tube.

How long is the tube to remain in the larynx ?

It must be removed as soon as possible. At the Edinburgh City Hospital the tube is generally removed after about 72 hours first. Then if re-intubation is necessary, the tube is removed as soon as possible thereafter. Sometimes a rising temperature is an indication that the tube is either doing mischief or that it has been in quite long enough.

According to Somerset of the Willard Parker Hospital (New York?) a child under two years should wear the tube for five consecutive days in primary intubations. But this from one's experience seems unnecessarily long. It occasionally happens that the patient must be hurriedly extubated, such as when the tube gets blocked with false membrane or thick mucous, then in all probability the child will need to be as hastily re-intubated. The pulse, temperature and general condition of the child, however, are fair indications as to the necessity of retaining or removing the tube.

One would be inclined to attempt primary extubation sooner, say after 48 hours, were it not that intubation at the Edinburgh City Hospital is delayed as long as possible, in the hope that by means of steam, antitoxin, fomentations and antispasmodics the operation may be dispensed with altogether. These cases then coming under operation as they do after as long a delay as is consistent with safety will naturally require the intubation tube for a longer period than would be necessary had intubation been resorted to immediately the respirations showed signs of obstruction, as is practised in some hospitals.

This delay in removing the tube very generally dispenses with the necessity of reintubation,

Oct.



No 7.

Temperature (Centigrade)

32500 Units Antitoxin

whereas if the tube were removed earlier re-intubation would be of much more frequent occurrence.

The Dangers of Intubation:

The chief dangers in the operation are the following:-

- (1) Sudden blockage of the tube while in the larynx, by membrane or thick mucus.
- (2) The risk of causing ulceration of the larynx.
- (3) The danger of increasing the dyspnoea by pushing false membrane before the tube.
- (4) The tube may be coughed up and the dyspnoea return in the absence of the medical attendant.
- (5) Intubation is often more difficult to perform than tracheotomy.
- (6) If the patient is extremely asphixiated reflex apnoea may be set up on intubation being attempted.

A Case illustrating danger No.3.

Stephen Lawrence Morgan: aet 2⁹/12 years.

Admitted 27th October. Discharged 3rd January 1907.

Is said to have taken ill on 26th October 1906. From his appearance we are inclined to doubt the accuracy of this, child looks as if he has been ill for nearly a week.

History of present trouble: Groupy, vomiting, headache and backache, all yesterday 26th. Admitted 27th.

State on admission: Patient looks very thoroughly poisoned, is pale (asphixia pallida stage) and is breathing heavily, throwing the head back and from side to side. Both alae-nasi and larynx are actively moving on inspiration. The indrawing is not very marked; patient appears to have no strength left to inspire deeply. The voice is practically absent. The cough is very markedly croupy.

The throat is congested. Tonsils are injected, enlarged, red and patched on both sides, the patching is extensive, very dark greyish black in colour; there is a very foul smell from mouth. Uvula and soft palate are both injected but clean.

The pulse is running, is faint and feeble, readily compressible and markedly irregular.

The respirations: Patient seems to have no strength to inspire deeply but respirations are very deeply laboured and crowing in nature. Free watery discharge comes from both nostrils.

Swab from throat, good rods, Hoffman, long thin rods; diplo- and staphylo-cocci. Nose: good rods diplo- and staphylo-cocci. Culture - both nose and throat - positive.

On arrival Ipecac. was not administered as pulse ^{was} too poor. Steam was put on full and patient was intubated immediately No.3 (O'Dwyer); the tube,

however, was coughed out immediately; the patient was re-intubated at once with like result. This time small plug of membrane (size of threepenny-bit) was coughed up and patient rested more comfortably for some hours. Had to be freely stimulated, Hypo, Ether ~~and~~ ^{xxv} into buttock after the second attempt. Patient settled down for several hours, after which breathing again became much laboured and both colour and pulse became bad, 12-20 a.m. (28th)

28th: Patient re-intubated. A metal tube was used on this occasion and tube was retained, good deal of spasmodic coughing was set up; no membrane, however, was expelled. Patient was stimulated by mouth and settled down.

28th: Fair night, tube in situ. Took nasal feed badly, was stimulated after and slept till 5 p.m. Half an hour later during fit of coughing tube was expelled. It was found necessary to re-intube within five minutes, but this gave no relief whatever, on the contrary, the breathing almost ceased, the tube had evidently rushed membrane down in front of it; tube was enucleated and immediately patient coughed up large tubular cast, distinctly marked with rings of trachea. After this breathing was much relieved. Patient was stimulated, was left and fell asleep, slept until 8-30 p.m. woke, became restless and breathing became very laboured,

and at 9 p.m. patient was intubated once more, again the metal tube was used.

31st: Very good night. Extubated at 11-45 a.m. Patient a little restless at first, settled down well after and has had a quiet day, although up to now, 9-30 p.m. has not slept at all since tube was removed.

1st November 1906: Fell asleep about 10-15 p.m. last night and had good night until 4 a.m. when pulse went off good deal (no vomiting) but responded after a time to hot stimulants. This morning patient still is a little croupy, but of good colour; respirations accompanied by very slight indrawing. Patient has on the whole had a good day, is interested in his surroundings and on two occasions was found sitting up in bed. Later in the evening the breathing again showed signs of obstruction, the breathing became very bad, the colour went off and indrawing was marked and patient was re-intubated (O'Dwyer No.3) at 5-30 a.m. the relief was immediate and complete, good day thereafter.

3rd: Good night, extubated at 11-20 a.m. Patient is breathing nicely and is not at all restless. Patient had a quiet day.

4th: The breathing became laboured, the colour and pulse went off towards mid-day. At 12-45 p.m.

patient was re-intubated once more (O'Dwyer 3), relief again was immediate. Quiet day until evening when patient became restless, a little flushed, and temperature, pulse and respirations all up (pulse 132). Has slept a great deal to-day.

5th: Good night, temperature, pulse and respirations coming down nicely. Extubated 11-45 this morning. Breathing very nicely, patient complains of some pain in the throat. At 10 p.m. the breathing became much more laboured, some indrawing, the colour and pulse, however, kept fair and patient passed a moderate night.

6th: Good day, breathing very much better, tube still remains out.

9th: Steam shut off altogether and patient made a good and complete recovery. Discharged from Hospital, 3rd January 1907.

In this case we fully anticipated cardiac failure; the patient was so very thoroughly poisoned that we gave the very gravest prognosis possible. The case undoubtedly illustrates the indisputable value of antitoxin, given in moderately large doses and frequently repeated.

This case also illustrates one of the difficulties occasionally met with in intubation, namely, the "Intubation of a cast". Another point it very clearly illustrates is the difficulty sometimes

experienced in keeping the tube from being coughed up.

Total, 32500 antitoxin units.

Other dangers are the making of false passages, laceration of the surrounding parts, intubating the oesophagus, these latter quite readily happen in the hands of inexperienced operators. "Retained tube" is a source of great trouble in some cases.

In the Medical Annual of 1905 "Berg recalls O'Dwyer's classification of "Retained tube" cases into the following groups:-

(1) Cases of prolonged stenosis, in which the original conditions necessitating the intubation persist beyond the usual length of time.

(2) Cases of prolonged stenosis, due to pathological changes which have arisen during or subsequent to the primary intubation and are not those of the diphtheritic process which necessitated the primary intubation. Such lesions are due

(a) To the injurious effect of the intubation tube upon the structures of the glottis, larynx or trachea:

(b) To traumatism produced by the operator either during intubation or extubation.

(3) Cases of persistent intubation due to paralysis of the vocal cords:-

(a) Temporary paralysis or spasm.

(b) Persistent paralysis. "

The ulcerations above referred to are fortunately rare since the introduction of antitoxin. These pressure ulcers according to Bandraud⁽²⁴⁾ in his "Thèse de Paris" 1897 are found to occupy the anterior part of the cricoid ring, and the inferior part of the arytenoid cartilages. The symptoms to which they give rise are hoarseness, aphonia, glottic spasm and laryngeal stenosis. When this ulceration has taken place tracheotomy should be done at once. These ulcers the Germans term "De cubitus", the chief dangers resulting from this decubitus are:-

(1) The swelling of the tissues round the ulcer, requiring re-intubation, which may eventually lead to destruction of the cartilages of the larynx.

(2) Contraction of the cicatrix formed when the sore heals.

(3) Opposing decubitus granulating ulcers becoming adherent" (Watson Williams⁽²⁵⁾ of

Bristol Royal Infirmary. Berg⁽²⁶⁾ says we have no positive means of diagnosing this decubitus during life, until its effects, stricture, atresia etc. have appeared except that late auto-extubation occurring after often repeated reintubations, positively indicates the presence of decubitus.

Tracheotomy rather than Intubation:

When would one do tracheotomy rather than intubation ?

(1) In private practice where the patient is not always within immediate reach of medical aid. Here tracheotomy must be practised, as a nurse can then readily attend the patient.

(2) If there is evidence that membrane extends below the larynx intubation will not relieve.

(3) If there is much oedema of the soft parts.

(4) In all patients over 12 years of age.

Intubated cases:

			Number of cases
Cases intubated once			10
"	"	twice	2
"	"	three times	3
"	"	four times	3
"	"	eight times	1
"	"	fifteen times	1
			(see James Quodberg's case).

Seven cases were intubated immediately on arrival.

Thirteen cases were intubated some time after admission on account of slowly progressive obstruction.

Cases admitted in Extremis,

Three cases, of which two died.

Cases admitted and at a subsequent time tracheotomized:-

Seven cases, five of which died.

The shortest time that any one patient required to wear the intubation tube was $8\frac{3}{4}$ hours.

The longest time the tube ^{primarily} was worn was 78 hours.

The most times a patient required intubation was eight times in one patient, and 15 times in another case.

Table of non-fatal cases.	Intubation alone.	
Number of cases.	Average dose of antitoxin.	Average duration in hospital.
17 = 85%	17412 units	37.2 days
Table of fatal cases.	Average dose of antitoxin.	Average duration in Hospital.
Number of cases		
3 = 15%	13666.6 units	8.3 days.

Table of intubated and tracheotomized cases:

Non-fatal:

Number of cases	Average dose of antitoxin.	Average duration in Hospital
2 = 33.3%	26250 units	32 days.

Fatal:

Number of cases	Average dose of antitoxin.	Average duration in Hospital.
4 = 66.6%	25750 units	21 days

One case arrived moribund, was first intubated twice without result, was then immediately tracheotomized without effect. In spite of artificial respiration and free stimulation patient showed no signs of response, was dead within five minutes of arrival.

The feeding of intubated patients:

I would strongly advise nasal feeding, at first at any rate, and, if the patient tolerates this well, continue ~~you~~ it all through the intubated period; this lessens the danger of broncho-pneumonia, produced by food or fluids getting into the larynx through the tube, to a minimum: it also lessens the chances of pressure ulcers forming - a common source of these ulcers is the act of swallowing. The patient should be left in bed - the head steadied and the catheter - a soft red-rubber, be first slightly lubricated with glycerine. The feeding apparatus is readily constructed, a soft red-rubber catheter connected to a red rubber drainage tube by means of a short glass rod, the whole surmounted by a glass funnel to receive the liquids. Before pouring in the liquids the same precautions must here be observed as are stated under tracheotomized patients. At first the patient must be fed very cautiously, the quantity and constitution depending upon the age

of the child. For a child of a year old milk $\frac{3}{4}$ to which some cream has been added, Borenine $\frac{3}{6}$., Whisky $\frac{3}{6}$, three or four hourly would be sufficient.

The attitude of operated cases:

I would in conclusion remark on the peculiar attitude taken up by intubated, and often tracheotomized cases, in bed. As a rule they do not tolerate being tucked in with blankets, but kick everything off and lie wholly uncovered. They generally toss their legs about very freely and it is only when they are asleep that one can cover them up, but no sooner are they awake when at once they kick the bedclothes off again. I can give no reason for this restless habit of operated cases, for before operation they lie covered and quiet, but as soon as they have been subjected to operation they assume this restless condition and refuse to lie covered.

In the Edinburgh City Hospital these little patients are generally dressed in woollens and their legs are kept warm by means of long thick stockings which are pinned to their upper garments, thus preventing them from becoming chilled by reason of their exposed condition.

Laryngeal Diphtheria in adults:

This condition is much less commonly seen in adults than in children, and when it does exist it is much more difficult to diagnose. One also sees fewer cases now-a-days than formerly; whether this is due to the more accurate measures of diagnosis or other influencing agents one cannot say. Within the space of eight months residency at a large Fever Hospital, one did not see a single case of laryngeal diphtheria in the adult - a single case was notified as such but bacteriological diagnosis contradicted the provisional diagnosis on two succeeding days. One would never attempt to intubate an adult patient, as these patients become too nervous and it would be subjecting them to unnecessary strain; tracheotomy is much to be preferred.

The steam rooms in the Edinburgh City Hospital.

This Hospital is equipped with four rooms which comprise the Steam room group. Each room is about 16' x 13' x 15', two rooms on the upper flat and two on the lower. The two upper rooms are very conveniently placed, one on each side of the Operating Theatre. Each room has accommodation for two patients, that is, there are two cots in each room. The steam apparatus is controlled

from the general heating apparatus of the Hospital. By means of a reducing valve the steam pressure is reduced from 60 lbs. (that is the pressure in the heating pipes) to 5 lbs. per square inch, and it is at this latter pressure that the steam escapes into the steam room. Each bed is supplied with two steam jets, one at either side, which themselves can be regulated to any pressure up to 5 lbs. per square inch. In this way one always has plenty of steam at one's command, the flow is evenly regulated and is constant. In this way one gets over a great many of the inconveniences experienced in working with the old fashioned steam or bronchitis kettle, the dangers (of fire) are absent and it requires much less attention on the part of the nurse.

A brief Summary of Cases:

Total number of cases 70.

Boys 40, Girls 30.

Cases analysed according to age:

One year and under	5 Cases
Two years " "	18 "
Three " " "	16 "
Four " " "	10 "
Five " " "	12 "
Six " " "	4 "
Between six & ten years	5 "
Total	70 Cases.

123.

Number of cases of Primary Laryngeal Diphtheria,
13 or 18.5%.

Number of cases of Secondary Laryngeal Diphtheria,
48 or 68.6%.

Number of cases of Laryngitis,
9 or 12.8%.

Number of cases operated upon, 33 or 47.1%.

Number of cases not operated upon, 37 or 52.8%

Number of cases intubated,
20 or 60.6% of operated cases.

Number of cases tracheotomized,
6 or 18.1% of operated cases.

Number of cases intubated and subsequently trache-
otomized, 7 or 21.2%.

Table of Cases:

Days ill before admission.	Number of cases.	Average dose of antitoxin in units	Average duration in Hospital (including deaths)	Percentage of deaths
1	0	0	0	0
2	8	5875	26.5 days	12.5%
3	25	9480	27.7 days	12.5%
4	13	19615.9	25 days	28.5%
5	9	16555.5	33.2 days	33.3%
6	5	20000	36 days	20%
7	7	13143	40 days	0%
10	1	10000	56 days	100%
14	1	10500	18 hours	100%

One case arrived moribund and died within five minutes of admission.

Table of Deaths:

Total deaths in non-operated cases	3 = 8.1%
" " " Intubated cases	3 = 15%
" " " Tracheotomized cases	3 = 50%
" " " Cases intubated and subsequently tracheotomized	5 = 71.4%
<hr/>	
Total deaths 14 = 20%	

Deaths under 1 year	Two cases.
" " 2 "	Seven "
" " 3 "	One "
" " 4 "	None "
" " 5 "	Three "
" Between 6 & 10 years ...	One "

Cases which died within 48 hours of admission:-

George C: aet 2 yrs. Arrived moribund. Intubated three times on arrival without effect, artificial respiration. Tracheotomy - no effect. Patient was dead within 5 minutes.

George L. aet 1 year. Intubated immediately on arrival. Died of cardiac asthenia 18 hours after admission.

Ella F. aet 1 year. Died within 20 hours of admission. Measles and Laryngeal Diphtheria.

Arthur H. aet $2\frac{1}{2}$ years. Intubated immediately on arrival subsequently tracheotomized, died in 30 hours of diphtheritic broncho-pneumonia.

James A. aet $1\frac{1}{2}$ years. Intubated on arrival subsequently tracheotomized, died in 36 hours, diphtheritic broncho-pneumonia.

Ella L. aet $1\frac{1}{2}$ years. Tracheotomized immediately on arrival, died in 40 hours of progressive asphixia.

In every case quoted in this Thesis in which intubation was necessary the operation was performed by Dr Ker, Medical Superintendent of the City Hospital, to whom I wish to express my thanks for permission to make use of the cases.

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